

## ABSTRACT

Title of Thesis:

WILDERNESS BY DESIGN

Aren Knudsen, Master of Architecture, 2017

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This thesis seeks to examine the relationship between landscape and dwelling through the exploration of the oppositions of wilderness and civilization. It questions how architecture can be a mediator for a life alternating between an uncultivated landscape and an organized society. How can architecture enable habitation without domination? This thesis questions how climate and landscape inform the way architecture facilitates nature as a means of understanding, happiness, and physical revival by enhancing one's connection to place. Through the exploration of structure, sustainability, architectural detail, the thesis will place architecture as the solution to coexistence and appreciation of nature in those who are accustomed to control.

# WILDERNESS BY DESIGN

by

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## Preface

*“In our success in creating an effective equivalent to nature, we have tricked ourselves. Our man-made environment now desensitizes us to nature. From within our climate-controlled buildings or as we cross the city or the landscape in the comfort of automobiles or airplanes, the natural world becomes detached from us, even abstract.” – Norman Crowe<sup>1</sup>*

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<sup>1</sup> Norman Crowe, *Nature and the Idea of a Man-Made World: An Investigation into the Evolutionary Roots of Form and Order in the Built Environment*, (Londres: The MIT Press, 1999).



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## Chapter 1: Background

### *Nature and the Built Environment*

*“Civilization attempts to control its surroundings, in varying degrees, removing wild things and converting wilderness into something more easily habitable.” – Roderick Frazier Nash<sup>2</sup>*

Wilderness is everywhere. When we define wilderness, we often associate it with abandoned landscapes and protected refuges. However, when examining the relationship between wilderness and civilization, wilderness becomes not only a place but a state of mind. Humans are children of this world, born into the natural environment and as such we are directly connected to it. The human spirit is analogous with nature; independent, unique, unconstrained, dangerous, beautiful, wild. It is these natural feelings that invigorate a sense of purpose, motivate us to pursue life, and give meaning to our place in the world. As such we are constantly searching for the things that make us feel alive and connected to our surroundings; that make us feel free and happy. Consciously or subconsciously, we yearn for that

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<sup>2</sup> Roderick Frazier Nash, *Wilderness and the American Mind*, (Conn.: Yale Univ. Press, 2014)



freedom and connection to the world that gives us a sense of place and belonging. It is in the most natural and primal elements of our lives that we find those desires.

In cities, we build pockets of nature within the built environment through parks and green spaces in an effort to capture those primal feelings in an accessible patch of wilderness. The most desirable residences in these locations are the ones that provide that connection to a piece of nature, physically or visually. One is hard pressed to find a person who does not enjoy and require some form of connection to the outside world. Whether it is vacations to the beach, neighborhood walks, or hiking through the woods, people need that time away from the city where they can immerse themselves in the natural world. Why is it then that humans seemingly work so hard to control, and in turn, destroy the environment and the elements of life that we so desperately desire?

When discussing why humans are on this earth, James Gibson wrote that “we do know from the most primitive to the most sophisticated among us, that our presence here is probably harmful, an imposition. This knowledge causes us to want to assuage the fouling and killing aspects of our existence in order to simply be at some ease with our occupation. We want to belong rather than only use.”<sup>3</sup> Though many would agree with Gibson’s sentiment, the truth is humans are destructive by nature and while we may not be actively seeking to destroy the environment, the evolution of civilization, and more specifically shelter, has culminated in destructive extraction and building philosophies.

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<sup>3</sup> James Gibson, *The Ecological Approach to Visual Perception* (New York, London: Psychology Press, 2015)

Throughout history, humans have sought to control their environment and convert their natural surroundings into something more easily inhabitable. In the context of man's most fundamental needs for survival, the built environment offers shelter and protection from the dangers of the wild. While most humans enjoy nature, and want to immerse themselves in it, they don't want to sacrifice the comfort and security that have become customary in the modern world. The exponential growth of technology has enabled people to ignore natural conditions of the environment and build almost wherever and however they please. A lack of awareness of the destructive nature of these practices has contributed to climate change and a reliance on resources that destroy the environment.

How then can architecture enable habitation without domination? Architecture is the physical merger between humans and landscape. As such, architecture should enhance our connection to the environment, not destroy it. As humans, we know our presence on this earth is destructive by nature. We want to belong, be a part of this world, not ruin it.

### *Project Scope*

This thesis examines how architecture can be the arbiter for nature and society, exploring how to reduce mankind's impact of the environment and create a sense of place within the landscape. It questions how architecture can enhance our experience and connection to place. As the impact of humans on the world is already evident with changing climates and intensifying weather, architecture needs to adapt new ways of removing the reliance on non-renewable energy to provide comfortable

living conditions while creating an appreciation and awareness of the natural surroundings.

This thesis looks at the elements of both human and natural influences on architecture to see how each can better respond to the other. By analyzing each of these elements and examining how they relate to one another, one can build architecture that is less harmful to the environment and facilitates the desire to be connected with the landscape.

#### Project Description

To explore how architecture can mediate the relationship between nature and society, this thesis turns to the Environmental Science Campus for the University of Maryland at Horn Point Laboratory in Cambridge, MD. By proposing a new master plan for the campus and introducing housing for the students, faculty, and staff that work there, the design will show how the principles outlined in this document can be applied at not only the building scale, but the site scale as well.

The Horn Point laboratory serves as an interesting case study because of its proximity to the nation's capital, its rich history in Cambridge, and the local circumstances which combine pockets of human intervention that are surrounded by rich landscape. These features make the site a microcosm of this relationship between wilderness and civilization that allow for many aspects of the opposition to be analyzed.

This thesis will introduce new structures to the site at varying scales and levels of detail. The masterplan will analyze both human and natural characteristics of the site to inform the opportunities available to facilitate the best academic

environment. At the building scale, this thesis will introduce a series of structures within the natural environment to provide dwellings for those who visit and work on campus in a way that enhances their connection to place. This program was chosen to emphasize the cyclical relationship that can be formed between building, program, and site. The strategies proposed not only create efficient dwelling but help inform the occupants on elements of the site, climate, and weather, the areas of study with which they are researching on campus. If a better connection to the landscape can be made, the building is able to be more efficient and engage the surroundings to further immerse the inhabitants and enhance the sense of place, improving their quality life and research in the process.

## Chapter 2: Theory

### Introduction

How does architecture enhance our experience and connection to place? The sites in which we build architecture are more than just the soil on which we lay the foundation. Each site in the world has specific human and natural characteristics that make it unique and different than any other. Though these characteristics may be subtle, once noticed, they can help to identify the site as a specific place in the environment. In urban locations, how architecture can connect to the “place” of a site may be easier to recognize. The history may be more obvious, the framework and plan of the site more easily rectified; architecture’s connection to place is supported by the buildings and culture surrounding it. However, when building in nature where the human impression is less distinct if present at all, these connections to place are more subdued and harder to extract. An architect’s ability to identify and connect their building to place can enhance the inhabitant’s connection to their surroundings, strengthening the structure’s purpose and helping it to make peace with its environment.

Before the development of technology and the spread of civilization into the untouched landscapes of the unknown, the barrier between wilderness and civilization was more easily defined. It used to be that there were pockets of civilization

surrounded by wilderness. Today it is the inverse, with pockets of natural landscapes that are surrounded by vast amounts of urban environments. As such, the way in which we define wilderness today must be analyzed to include not only the places that are free from human influence, but places that create those wild feelings that are analogous to the untrammeled landscapes of true wilderness.

When most people think of wilderness they think of untouched landscapes, lacking order and free from human control. But as these typical wilderness environments dwindle and disappear, we must understand the other forms of wilderness that may be more prevalent in our everyday lives. Landscapes that are immediately surrounded by cities, pockets of nature that we may escape to on a daily basis, such as Central Park. These areas are more controlled, created by humans but may still activate the same wild and free moments that we experience in true wilderness, though they may be momentary. Another form of wilderness is that of the urban hardscape. Areas that were physically formed by humans and subsequently abandoned at some point in their life. These often have the same characteristics as natural wilderness – uncontrolled, and somewhat foreboding. Finally, there is that of the middle landscape, the grey area between wild, untouched nature and civilization. The areas are caught between two very opposing environments, where these worlds begin to blend together. These are the landscapes where one feels isolated and free from human control yet is still within a few minutes of civilization. The moments where human's impression is subtle enough that we don't immediately recognize its influence. It is here, in the landscapes where nature and society begin to rub together where architecture plays its most important role in the connection to place.

How architecture enhances our connection to place can be identified in a set of design principles, categorized by the ways in which they enhance our connection to the surrounding landscape. Though they don't identify every aspect with which buildings may connect us to place, they provide a framework or starting point to begin to question the validity of a building's presence in the environment. The physical, cultural, and metaphysical ways in which we design highlight specific areas in which architects can begin to enhance the connection to place.

### *History of Wilderness and Civilization*

*“The transition from a nomadic hunter-gatherer society to one that resides in more or less permanent structures located in settlements profoundly changed the way people think, especially about the natural world around them.” –Norman Crowe<sup>4</sup>*

Wilderness and civilization are best defined by their relationship to one another. When civilization began, the wilderness was only considered “wilderness” because it wasn't civilized. The uncivilized became wild. In this sense, wilderness and civilization are intertwined more than we perceive. Wilderness can be defined by wild people, not just nature. Although this thesis focuses on wilderness as a place in the landscape, the essence of “wild” plays an important role in discussing how people interact with the natural world. As it relates to the natural world, the Wilderness Act

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<sup>4</sup> Crowe, *Nature and the Idea of a Man-Made World*

of 1964 defines wilderness as “an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain”.<sup>5</sup>

#### Romanticism and the American Landscape

Romanticism developed a feeling for natural beauty among writers, painters, tourists, and naturalists. The idea of rediscovering the landscape became an important discussion in the planning of cities. This movement occurred later in America than it did in Europe but expressed itself in the same ideas that reconnected people to the natural environment. New laws were developed to protect wildlife, houses were painted more natural colors as opposed to white in attempt to better blend into the landscape, vacations and activities that immersed people in the environment became more popular, and more green spaces and trees were introduced to cities. The importance of that connection to the natural environment was not lost on the mindset of people at the time.

*“A beautiful landscape came to mean a natural landscape, one which man had altered little or not at all. Contact, however brief, with such a landscape led to an awareness of eternal values and to a questioning of one’s ultimate identity.” – JB Jackson<sup>6</sup>*

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<sup>5</sup> “Wilderness Act”, Public Law 88-577 (16 U.S. C. 1131-1136) 88th Congress, Second Session, September 3, 1964

<sup>6</sup> J.B. Jackson, *Selected Writings of J.B. Jackson, Several American Landscapes*, (Cambridge – Mass: University of Massachusetts Press, 1970), 51



## Technology's Impact on Civilization

Modernists such as Corbusier and his Maison Domino house created a new primitive hut. This time was characterized by the detachment from architectural expression and connection to the past to simplify and reduce a building to its most functional. In the process of simplification, all connections to the past were lost. Contemporary architecture has evolved with the modernist mindset and continues the tradition of disconnecting the building from place in many instances. Function, utility, and technology drive contemporary architecture. The money driven, development minded expansion of civilization has spawned buildings that are designed to be low cost and constructed fast as possible. The convenience of technology has encouraged people to ignore the building's context and mitigate the subsequent problems with technology. Large amounts of glazing inviting too much solar exposure is compensated by mechanical systems that burn energy to cool the building unnecessarily.

## Stigma of the Environment

The disconnect between building and environment continues to drive a wedge between nature and humans. The more our lives ignore the influence of our environment, the more we rely on the parts of civilization that damage that environment, such as fossil fuels, further increasing the disconnection. Now that the world's climate is undergoing significant change, awareness of the damage people is causing is becoming more common. Though more people are working to change civilization's bad habits, the conversation over climate change and the environment has developed a social stigma.

To speak about the environment and the need to protect the wilderness of the world is to label one's self as a hippie. The conversation has become partisan with many no longer forming opinion based on fact but political hive-mind. Many of the average citizens in America speak to the need to address climate change but the conversation has been around long enough, with little being done, that people have become numb to the issue.

This stigma associated with sustainability and the environment is an area in which architecture has the potential to shift people's attention and encapsulate a broader demographic of people in the discussion of the environment. If more buildings reflected the environment around them, more attention would be paid to the wonderful influence nature can have on the built environment. Not only do buildings become more energy efficient but they begin to reflect the regions in which they're built, strengthening the sense of place. Sustainability doesn't have to be expensive, nor does it require new technology or progressive building techniques. Looking to how primitive man and nature have created protection from the climate for millions of years, cost effective, sustainable building strategies can be combined with contemporary architecture to develop a new standard of design.

### *Metaphysical Connection to Place*

Human's spiritual connection to place is one that can be challenging to articulate. It is the spiritual ways in which we perceive the environments around us. The way architecture and our surroundings invigorate the senses and create feelings that may be more powerful than ourselves. A few of the primary principles of these

connections can be identified in the way the architecture creates implied connections to time, memory, and the senses.

#### Sense

The elements that connect humans to architecture and the environment around us are those that we understand with the senses. The texture of a surface, the light in a room, or the temperature around us, all have a connection to how we experience place. The ways in which architects can invigorate the senses should be considered in how they relate back to the site of the building. In the natural environment, parallels should be drawn between the way the site naturally activates the senses and the ways the architect activates the senses in a building.

#### Time and Memory

Analyzing the site through a historical lens can lead to clues of the natural and human impressions that were left from a time past. In rural landscapes, the impressions on the landscape from the cultivation of land leave clues to an agricultural history. These impressions can guide decisions made in the placement or program of proposed buildings that help tie the structure back to its historical connection to place.

#### *Cultural Connections to and Experiences of Place*

Our cultural connections to place are ones that relate more to the human characteristics of the site than the characteristics found naturally. The ways in which humans have built in the region through history, the religious history of the site, or contemporary habits that question how humans became so disconnected from the

environment around us. These cultural connections can be thought of in broad terms at the scale of humans down to the local scale that examine the immediate cultural attributes of the site.

#### Predictable Environments

Humans feel most comfortable when they are surrounded by things that are familiar. When we are taken out of the familiar environment, we search for things that imply the same sense of security. Within the context of the building this can mean literal security, from wildlife or the weather, or security in knowing you belong in that environment.

Dwelling in nature should scare you. It should bring feelings of fear and anxiety when without those elements that protect us. Nature is formidable, behind our climate controlled buildings and highway wrapped cities, we forget the power of an uncontrolled environment. Dwelling in the wilderness does not have all the comforts of home and should not have all the comforts of home, but it needn't be primitive either. Although the primary role of architecture in the wilderness is to protect occupants from the dangers of their surroundings and facilitate access to remote locations, at its most efficient it also provides a comfortable living environment that facilitates contemporary human needs.

#### Place-making

One of mankind's most fundamental needs is a sense of place. Place is the feeling of comfort that comes with familiarity and the recognition of home. At its most fundamental, the building should resolve that desire for place and the feeling of

home. Evidence of successful placemaking comes in the form of a loss of words in describing memories to a friend, or an experience powerful enough that words can't articulate the impression it leaves. It is the ability for a place to engrain a feeling into a memory that highlights a moment's importance in life.

*"A sense of place concerns that need to find a familiar landscape as refuge from the unknown, perhaps from the terrifying prospect of being set adrift in what would otherwise be a dimensionless, time-less, and chaotic world."* – Norman Crowe<sup>7</sup>

The elements that invigorate a sense of place are ones connected with nature; the quality of light, the feel of the air, the smell of the grass, or the blanket of climate. Architecture that enables interaction with these elements and facilitates the creation of moments that we associate with a sense of place do so by their ability to engage with their surroundings through their form, material, and structure. The design and building technique should stimulate senses that strengthen the psychological connection with the place.

## Hearth

The hearth has been one of the most prominent elements in dwelling since it was used in primitive architecture throughout the world. It is the organizing element that can provide warmth for survival in cold climates, heat for cooking, or used as a communal element for social gatherings. The hearth's position and prevalence in the

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<sup>7</sup> Crowe, *Nature and the Idea of a Man-Made World*, 71

home can indicate a building's climate and social stature. In colder climates, the hearth may be positioned in the center of the dwelling, its heat radiating from the inside out, heating as much of the building as possible. In warmer climates, the hearth might be placed towards the exterior walls, or in a separate building for cooking. This keeps the heat that it generates away from the home and helps keep the structure cooler.

Throughout time, the most common material used to build the hearth has been masonry. As technology developed and cast-iron hearths became more prevalent, its role in architecture became less prominent. The ability to generate heat without the need for a large masonry structure meant the hearth could be integrated into the building in more subtle ways. Today, the hearth is more of a decorative element than a necessity, with fire made of LED lights or powered by gas. As such, the importance of the hearth as an organizational element in the dwelling is lost on many architects.

The hearth is the one element in the building that can connect the ground, the building, the inhabitants, and the sky in one move. A masonry hearth is grounded to the foundation, runs through the building, and breaks through the roof to become the tallest object on the building. When in use, the smoke of the hearth dissipates into the sky and can be seen from afar. The heat and light the hearth generate activate the senses of the user, helping bridge the connection between the building and the inhabitant. These connections help solidify the hearth as an important component in how the building helps bring together humans and the landscape.

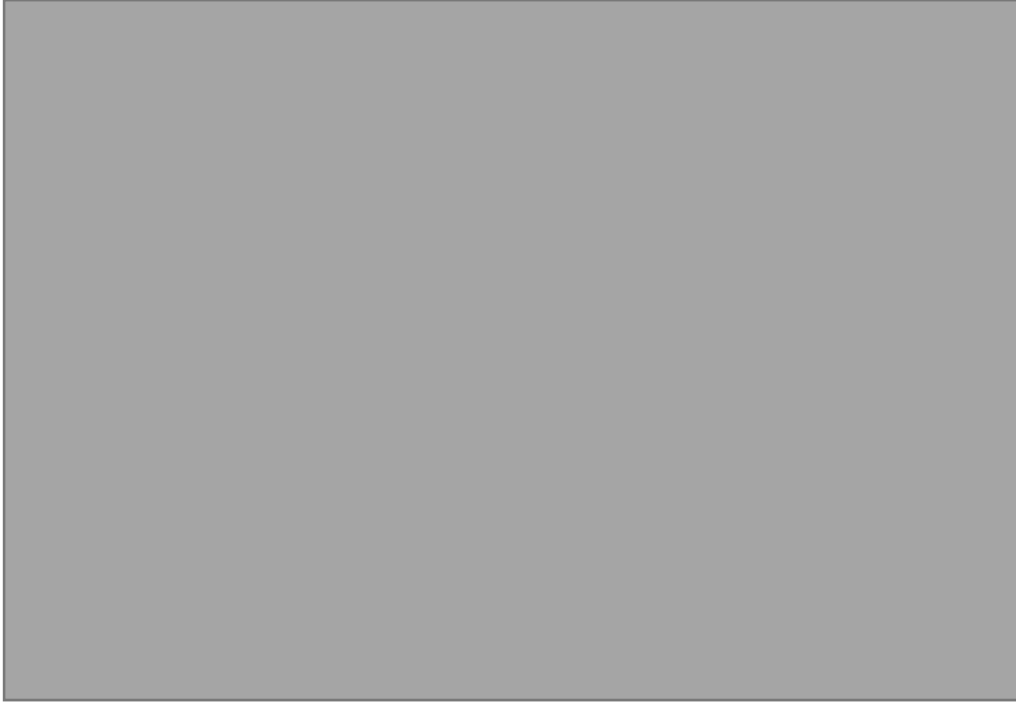
### *Physical Connections to and Experiences of Place*

The physical ways in which architecture can enhance our experience with place are numerous. Many of these principles draw parallels with the way nature

connects us to our surroundings, through light, views, and climate. The physical connections between the architecture, landscape, and the inhabitants are those that may be the most obvious. Their connections articulated by the aspects of our lives that are most prominent and at the forefront of our awareness. Though the ways in which they connect us to landscape may be obvious, they are most effective when they go unnoticed.

#### The Human Scale

The human scale references how people move through the world and the way we use our bodies to measure our surroundings. The mind is constantly noting the aspects of its surroundings, the temperature on your skin, the vicinity of objects, nearby sounds or lack thereof. Subconsciously, the body knows when something is out of place. When it doesn't feel correct, it feels unnatural. In the discussion of architecture, the body is the best critic. Spaces should respond to the movements and proportions of the body, adapting to its occupants.



**Figure 1 - Sheltering of the bay window and its position on the stair landing contribute a sense of comfort and security for its occupant** (*drawing by Norman Crowe*)

#### Tectonics

The decisions architects make regarding the structure of the building is one that starts with material. Steel, concrete, wood, masonry – these decisions affect the sizes of spaces and the finishes we use to either expose or hide them. Structural decisions made in the built environment of a city may be much different than those made in the natural environment. These decisions in a city may be based primarily in cost or span, whereas access, sustainability, and maintenance may be more important in remote landscapes. When considering how these elements enhance our connection to place, whether the materials can be found on location affect the prominence with which that connection is made.

The spatial requirements of the space may determine how the structure is used to help define program in a building. For a structure in the landscape, a space that



requires a more flexible program could be served well by having structure that is pushed to the periphery, leaving the center of the space open to service a variety of uses.

Similarly, how the structure meets the ground may serve a greater importance when building in the landscape. Slab on grade construction requires flat topography that may be more susceptible to flooding. Structure placed on concrete footings can adapt to a variety of topographic conditions, lifting the building off the ground and reducing the need to reshape the environment. Though none of these decisions are right or wrong on their own, considering their impact on the surrounding environment is important in understanding the merger between building, humans, and landscape.

#### The Natural State

*“When the work is completed, the beginning must be felt.” – Louis Kahn*

The evidence of human’s impact on the natural order is articulated to the senses through materials. Materials that are raw and unrefined hold a stronger relationship to nature than various stages of refinement. The materials that are chosen for a building should reflect its surroundings. Not all aspects of the building need to be composed from natural materials, but the selection of where to mimic nature and where to juxtapose human’s presence within it must be conscious.

The level of human refinement on materials at the smaller scale will ultimately affect the character of the building when it is complete. For instance, the natural states of a brick are clay and mud. Homes made from clay have a character

distinctly connected with nature and the materials that compose the structure. When the mud and clay is formed into brick, the bricks are then used to form a building that is unrecognizable to nature. As such, the building's form and dimension are directly influenced by the natural state of the material used.

### Spatial Configuration

How we move through the site or building can change our perception of place. Whether we move in a purposeful manor that simply gets us from one point to another in the most direct way possible, or whether we create experience in that movement with moments highlighted by the architect to experience a view or interact with a certain element. Architects create these moments through the shape of a room, size of a threshold, or sequence of architectural elements.

When considering how we move through a natural or built environment, the procession through space can be very different. Movement through a built environment may sequence a series of human elements that are more rigid, orthogonal, holistic, and ordered. Movement through a more organic landscape might be defined as more meandering, subjective, and perceptual. Therefore, the decisions we make to processes between the built and natural environment must be made carefully, considering how these movements may affect the connection to place.

### View

The way in which views of the surrounding environment are framed or created is key to enhancing one's connection place. The visual connection to place is one that can be thought of at both the urban and building scales. Nature itself is one of the best

examples of this principle being implemented. The way a path between trees clears to frame a view into the distance or the transparency in vegetation providing glimpses of features ahead. Finding parallels in the site conditions and the methods for design can create strong connections to the environment where the building is located.

At the building scale, the decisions we make with the elements of the structure that connect us to the outside world are important to consider. Whether glazing is fixed or operable, the design of the mullions, or whether the glazing can be removed entirely. Fixed windows offer opportunities to frame the landscape beyond the building, like a frame for a photograph. The building becomes a canvas and the environment is the subject. In this analogy the architect is the painter, making conscious decisions of what perspective to use and what subject to paint.

#### Climate

When building in the landscape, the climate in which the building is located should have more impact on the architectural form than any cultural, social, and functional aspects of the design. It is through the adaption to a site's climate conditions that the cultural, social, and functional considerations can be the most successful. The elements of climate and weather that directly impact the building can be categorized into three primary categories; solar exposure, precipitation, and ventilation/wind. As such, the building's orientation on site directly impacts all three building categories. Although the building's orientation is affected by other factors such as topography and views, just as important is how the building's orientation will relate to the sun and wind patterns on site.

Throughout history, human's relationship to the sun has been important both physically and spiritually. The sun's radiation provides warmth and light, facilitating life and enabling human existence. It can also be life threatening, exhausting the body under long exposure. The natural features of the landscape offer the first line of defense against the weather, most often in the form of trees. Considering the building's relationship to trees can mitigate the effects of sun, wind, and rain, on the structure in an efficient and cost-effective manner. Deciduous trees can even adapt to the seasonal changes of the climate, providing shade in the summer with thick canopies while still allowing sun into the building during the winter when the leaves have fallen. In areas with frequent wind, thicker canopies help filter the air as well as deflect sound away from the building.



**Figure 2 - Deciduous trees natural shading changing with the seasons** (*drawing by Paul Gut*)

#### Solar Exposure

The sun's relationship to the building impacts the comfort or distress of the occupants by its direct effect on the lighting and temperature. In colder and temperate climates, the building should face the south, with flexibility for variation up to 30 degrees to the west or east. In warmer climates, the building should face east to reduce the radiation and insolation of the sun on the structure and make the most of

cooling winds. Cooler morning temperatures can be mitigated by positioning high use spaces on the eastern side of the building, absorbing the radiation faster than other parts of the building. Knowing this information, the sun begins to affect not only the orientation but the form and use of materials as well.

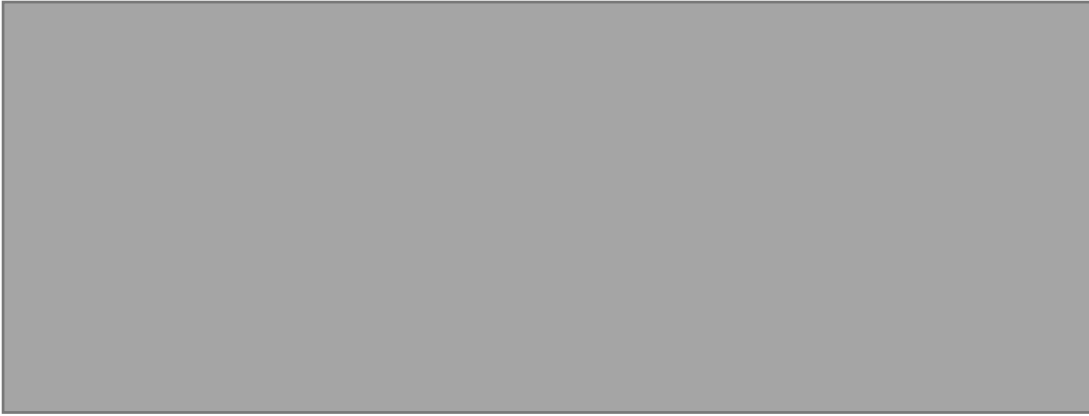
Considering the thermal properties of materials, especially in warmer climates is vital to maintaining the “comfort zone” for occupants. How the building’s skin blocks or allows light into the building must be considered in conjunction with wind and ventilation. In hot and humid zones where the breeze is vital in cooling moisture on the body, the building’s skin must not only provide adequate shading but be airy and transparent enough to allow for proper ventilation.

## Wind

In warmer climates, the ability for the building to breathe can play a significant role in the efficiency of fostering comfortable living environment. In colder climates, creating comfortable living conditions means protecting occupants from the wind. In both contexts, how the architecture interacts with wind conditions is another primary climate element that can shape the design of the building.

In instances where protection from heavy winds is required, trees become more necessary in insulating the site. Their influence on the wind at ground level is important to controlling the impact on the building. As discussed in Victor Olgyay’s book *Design with Climate*, using trees to create windbreaks diverts air upward and away from the building, creating pockets of refuge from the wind. The leeward side

of windbreak provides the most protection, as you move further from the windbreak the wind intensifies as it descends back to the ground.<sup>8</sup>



**Figure 3 - Tree canopies filtering the wind resulting in cleaner air** (*drawing by Paul Gut*)

In climates where the need for the building to ventilate and harness the wind to help cool the interior, the form of the structure and openings along the facades should be considered. Buildings with an open floor plan will more easily ventilate than ones with partitions. Where partitions are necessary they should be placed parallel to the wind direction as to not block cross ventilation. Large openings do nothing to cool the building unless they are paired with an opening on the opposite wall, ideally of the same size and unobstructed by any solid objects such as walls or large furniture.

Where a series of buildings are placed on one site, the relationship each building has to the other affects the air path and the subsequent effects of the wind. In hot and humid locations, staggering a group of buildings as to not obstruct one another can maintain the positive benefits of ground level wind patterns.

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<sup>8</sup> Victor Olgyay and Aladar Olgyay, *Design With Climate: Bioclimatic Approach to Architectural Regionalism*, (Princeton, NJ: Princeton University Press, 2015), page 98



**Figure 4 - Buildings position as not to obstruct each other from the wind** (*drawing by Paul Gut*)

Where protection from wind is required, buildings should be grouped close together and protect each other from the wind. Ideally, programs of frequent use should be placed on the inside of the cluster. Outlying buildings will be affected by the wind but simultaneously protect inner buildings.

#### Precipitation

The roof is important in shedding water and snow, in addition to affecting the way air moves inside the building. Steeper gable roofs will be more suitable for high precipitation climates. The use of materials on the roof can affect insulation and sensory aspects of dwelling (such as the sounds different materials will make when it's raining). Here the building is interacting with the occupants and the site conditions.

In cold climates with lots of snow, the building wants to either be lifted off the frozen ground or burrowed into the landscape, making use of natural protection from the wind and insulation of the earth. In hot and humid climates, the building wants to be lifted off the damp ground and into the breeze above. This provides protection from animals and flooding, most important being keeping the building dry. The

structure required for lifting the building off the ground is also more accessible in a remote landscape, especially one that is primarily under water at various points during the year.

#### Landscape / Topography

The topography of the site affects the way the building meets the ground, the views out of and into the building, as well as the passive strategies used to heat or cool the building. These factors change how we interact with the building and how we perceive the landscape around it.

Locating the building near water will cool the temperature of prevailing winds before reaching the shore. Wind itself is also shaped by the topography and is especially influential in valley's where wind is funneled, like an alley between buildings. Flat areas offer little protection from the wind, the lack of obstructions allowing for wind to hit the building without mitigation. Here vegetation is important to help reduce wind speeds and filter air that may be filled with sand and dirt from the open landscape.

#### Building for change

Natural circumstances like summer and winter and the degree to which they vary impacts how much the building needs to adapt to changing weather on an annual basis. The human impact on this idea is seasonal occupation. If the building is only used during certain months during the year, how does it operate uninhabited? Other human factors include adjusting to the number of people inhabiting the site at one time. As seasons change, the number of occupants will change as well. Summer



months may see an influx in the number of units needed to provide dwelling while the winter months may require less. The ability for the building to adapt and respond to the needs of the climate, site, and occupants becomes critical when determining the size and number of structures that should be used on site.

## Chapter 3: Analysis of Climate and Wilderness

### Intro/Background

*“Wilderness is the land that was - wild land beyond the frontier...land that shaped the growth of our nation and the character of its people. Wilderness is the land that is - rare, wild places where one can retreat from civilization, reconnect with the Earth, and find healing, meaning and significance.”<sup>9</sup>*

The juxtaposition between wilderness and civilization is no more poignant than in the protected wilderness areas of the United States. As civilization spread and technology advanced, action was needed to halt the destruction of the landscape before all traces of human’s primordial relationship to the earth was lost. It is within these few remaining swaths of nature that questions of the built connection between humans and nature arise. It is in these landscapes that we find the natural characteristics that connect us to place and begin to understand how they help define the natural environment.

This thesis began with the study of four sites, located in four diverse areas of the United States: Glacier Bay, Alaska; the Olympic Peninsula, Washington; the

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<sup>9</sup> “Connection federal employees, scientists, educators, and the public with the wilderness heritage,” Wilderness Connect, accessed September 2017, <http://www.wilderness.net>.

Petrified Forest, Arizona; and the Everglades, Florida. Each site offers its own unique topography, climate, and wilderness condition. All four sites are designated wilderness locations by the United States Congress and the Wilderness Act of 1964. Each was selected to analyze its unique climate conditions, diverse biomes, and wild nature, protected and untrammeled. The study of these climate conditions informs how humans have built in similar environments throughout history, helping to identify those architectural techniques that are specific to each place. Though these techniques might not be implemented directly today, they highlight ways in which architecture reacts to physical site conditions that can inform the buildings connection to place.

### Wilderness Classification

In 1964 President Lyndon B. Johnson and the United States Congress enacted the *Wilderness Act*, designating 9.1 million acres in thirteen states as wilderness. These areas were established as part of The National Wilderness Preservation system which is administered by four United States government agencies: The National Park Service, the U.S. Forest Service, the U.S. Fish and Wildlife Service, and the Bureau of Land Management. Today there are 765 wilderness areas in 44 states and Puerto Rico.<sup>10</sup> The Wilderness Act defines wilderness as follows:<sup>11</sup>

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<sup>10</sup> Wilderness Connect. "Connecting federal employees, scientists, educators, and the public with their wilderness heritage"

<sup>11</sup> "Wilderness Act"

"...lands designated for preservation and protection in their natural condition..."

Section 2(a)

"...an area where the earth and its community of life are untrammelled by man..."

Section 2(c)

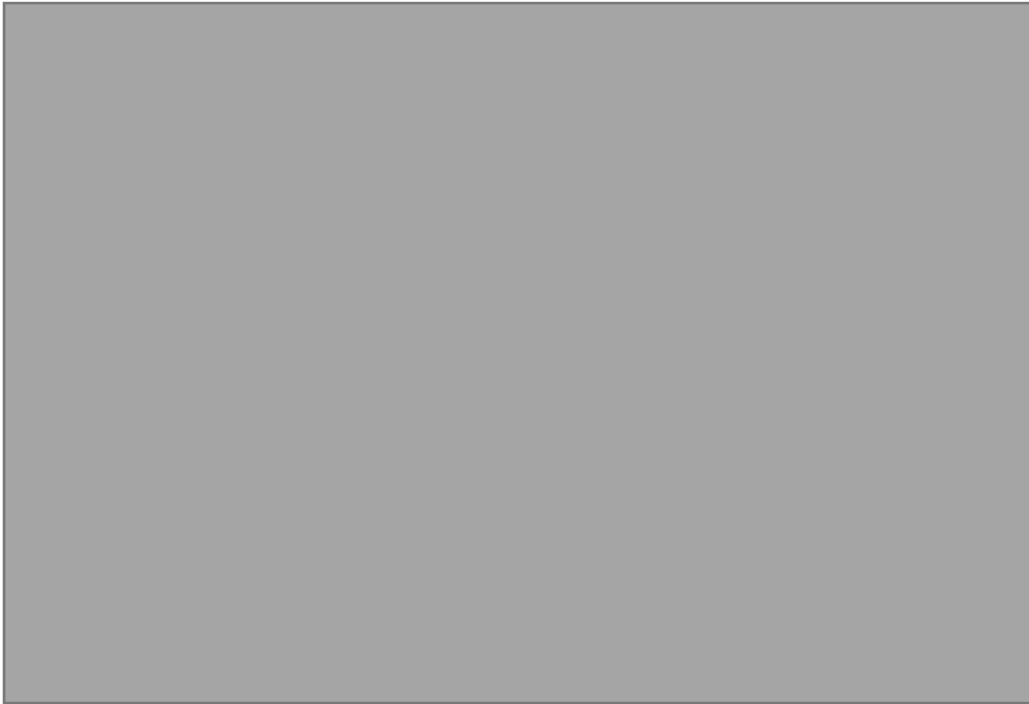
"...an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvement or human habitation..." Section 2(c)

"...generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable..." Section 2(c)

"...has outstanding opportunities for solitude or a primitive and unconfined type of recreation..." Section 2(c)

"...shall be devoted to the public purposes of recreation, scenic, scientific, educational, conservation and historic use." Section 4(b)

## Glacier Bay



**Figure 5 - Lamplugh Glacier in Glacier Bay, Alaska** (*NPS photo*)

Designated as wilderness in 1980, Glacier Bay is comprised of over 2 million acres in the southeastern portion of Alaska.<sup>12</sup> Remote and untouched by man, it is one of the world's largest protected Biosphere Reserves and is classified as a World Heritage Site by the United Nations.<sup>13</sup> The environment is a melting pot of geological land forms with tall, rugged mountains and deep, glacial fjords. The southern portion of the bay is covered by temperate forest contrasted sharply by the rocky, icy, region of the bay to the north. The summer days are long, leaving only a few hours of darkness as the sun briefly dips below the horizon. The site is an environment of dynamic change and offers distinct visual evidence of the impact of climate change

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<sup>12</sup> Wilderness Connect. "Connecting federal employees, scientists, educators, and the public with their wilderness heritage"

<sup>13</sup> "Glacier Bay," Southeast Alaskan Wilderness , accessed May 2017, <http://www.nps.gov/glba>

on the region, making it a valuable location for analysis of the interaction between nature and building.

## History

Glacier Bay has a vast cultural and environmental history. Parts of the area have been home to the Tlingit (pronounced “Klingit”) peoples, who are believed to have occupied southeastern Alaska for over 11,000 years.<sup>14</sup> The environment has changed dramatically over the last 100 years, impacting the landscape and its wildlife inhabitants as temperatures rise. The receding glaciers have become a way for scientists and researchers to evaluate the effects of a warming climate, providing measurable data to analyze. The Muir Glacier in Glacier Bay has retreated more than 31 miles since 1892 and thinned by more than 700ft., giving way to new vegetation and a dramatically different environment.<sup>15</sup>



**Figure 6 – (Left) Northeast photograph of Muir Glacier Sept. 2, 1892** (*H.F. Reid/National Snow and Ice Data Center*)

**Figure 7 – (Right) Muir Glacier Aug. 11, 2005** (*USGS/Bruce F. Molnia*)

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<sup>14</sup>“Tlingit”, Countries and their Cultures, accessed May 2017, <http://www.everyculture.com/multi/Sr-Z/Tlingit.html>

<sup>15</sup> “Repeat Photography of Alaskan Glaciers,” Glacier and Landscape Change in Response to Changing Climate, accessed May 2017, [https://www2.usgs.gov/climate\\_landuse/glaciers/repeat\\_photography.asp](https://www2.usgs.gov/climate_landuse/glaciers/repeat_photography.asp)

## Climate

The weather is variable, with temperatures at sea level being milder than the higher elevations in the mountains. In the summer, the sea level climate is impacted by ocean currents, with temperatures averaging between 50 and 60 degrees during the day, and low's in the 40's at night. Winters are much colder and the weather becomes more severe at the higher elevations. Parts of the bay receive almost 70 inches of rain in the summer and 115 inches of snow in the winter.<sup>16 17</sup>



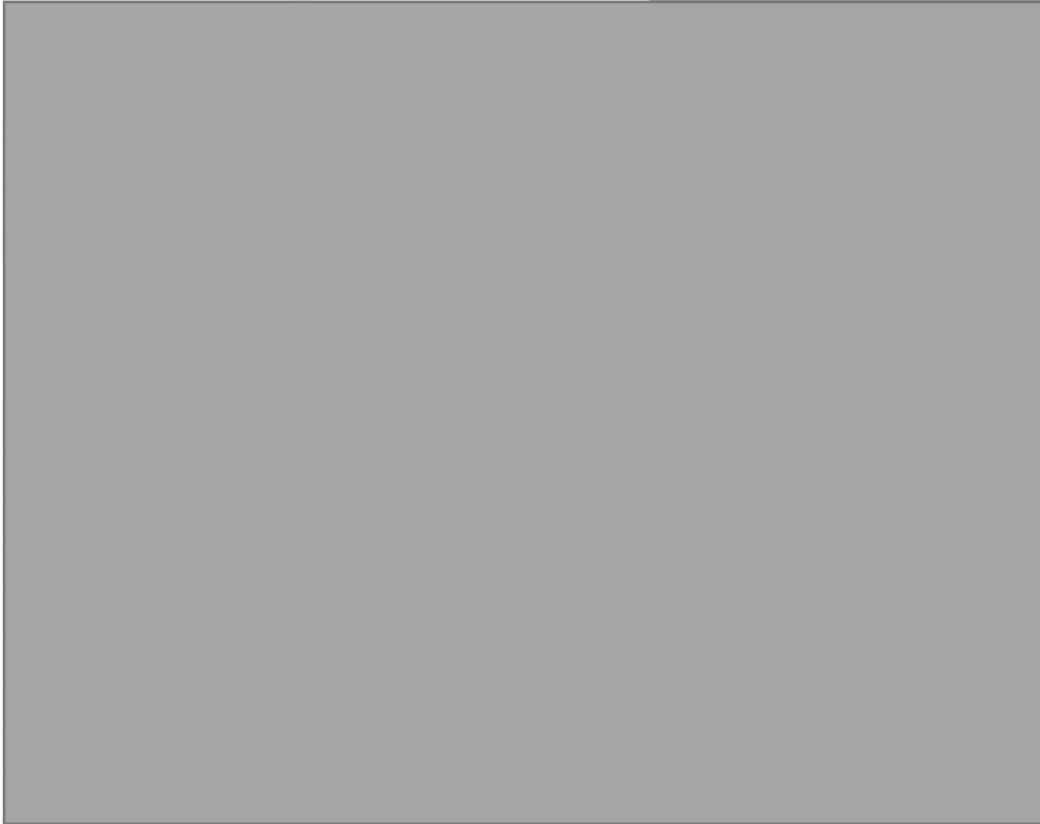
**Figure 8 - Climate Data for Glacier Bay** (*Western Regional Climate Center*)

The summer is characterized by long days and short nights, sunlight can be visible for roughly 21 hours on certain days. This is in stark contrast to the winter, when it's possible to receive only eight hours of sunlight in a day.

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<sup>16</sup> National Park Service, "Glacier Bay"

<sup>17</sup> "Glacier Bay, Alaska (503294)," Period of Record Monthly Climate Summary, accessed May 2017, <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak3294>



**Figure 9 – Sunlight, sunset, dawn and dusk times, graph** (*gaisma.com*)

**Figure 10 - Sun path diagram** (*gaisma.com*)

**Figure 11 – Sunlight, sunset, dawn and dusk times, table** (*gaisma.com*)

#### Environment / Ecology / Vegetation

The biome of Glacier Bay is highly influenced by the tidewater glaciers that shape the surrounding environment. As the glaciers advance and retreat, they give way to a variety of plants and animals, including fish, birds, as well as land and sea mammals. What were once mud and rock filled beaches become luscious swaths of green vegetation that attract new life to the shores. Much of the surrounding wildlife relies on the ocean and its biologically rich environment for their survival. The



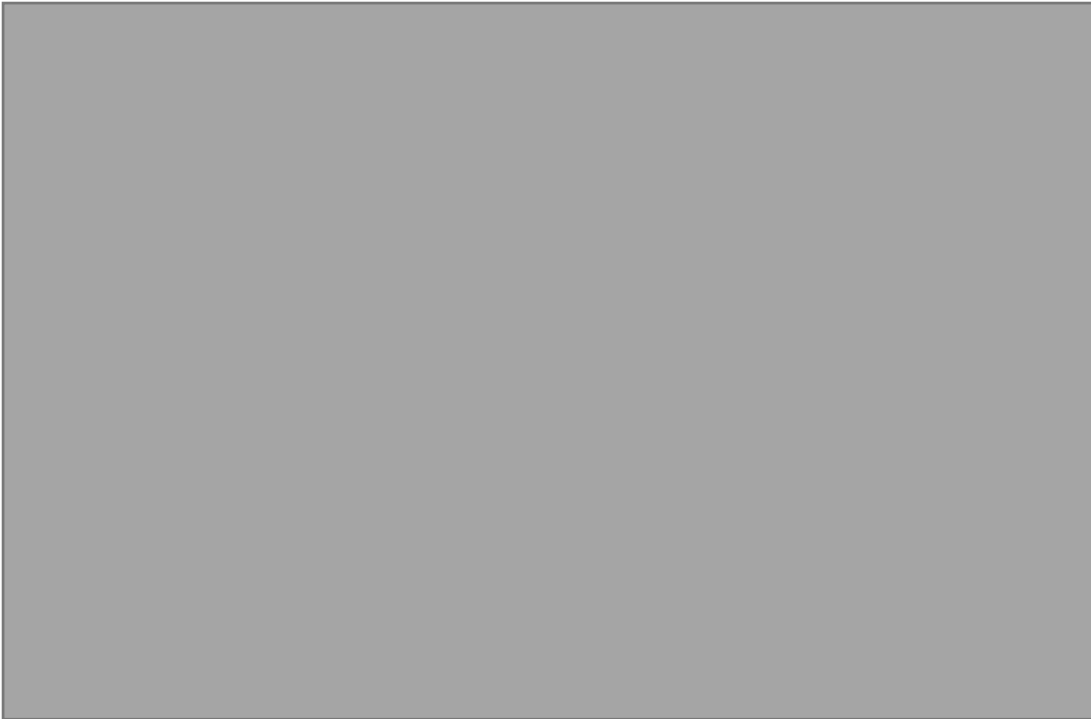
region's tides fluctuate drastically, changing the bay waters as much as 25ft. in a six-hour period and impacting the animals that live in the area.<sup>18</sup>

To the south, away from the frozen landscape, temperate rainforests cover much of the land. Evergreen trees are abundant, their trunks blanketed in a variety of low lying vegetation such as mosses and flowers.<sup>19</sup>

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<sup>18</sup> "Glacier Bay," Natural Features & Ecosystems, accessed May 2017, <https://www.nps.gov/glba/learn/nature/naturalfeaturesandecosystems.htm>

<sup>19</sup> "Glacier Bay," Glacier Bay National Park Forest, accessed May 2017, <https://www.nps.gov/glba/learn/nature/forests.htm>



**Figure 12 - Olympic Rain Forest** (*NPS photo*)

Daniel J. Evans Wilderness, once known as Olympic Wilderness until 2016, is a designated wilderness area located within Olympic National Park in Washington state. It received the wilderness designation in 1988 and includes more than 800,000 acres of land.<sup>20</sup> The wilderness encompasses a variety of climate conditions from the snowy peaks of Olympic mountains to the temperate rainforest valleys of the west and south. Lower elevations are characterized by their annual precipitation, receiving 140-180 inches of rain a year.<sup>21</sup>

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<sup>20</sup> Wilderness Connect. "Connecting federal employees, scientists, educators, and the public with their wilderness heritage."

<sup>21</sup> "Elwha Ranger Stn, Washington (452548), Period of Record Monthly Climate Summary, accessed May 2017, <https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?waelwh>

The Daniel J. Evans Wilderness provides an ideal site location for a field research facility. The diverse conditions within the region bring several climate locations within reach of each other in the same wilderness.

## History

Olympic National Park was established in 1938 by President Franklin Roosevelt has since become a designated Biosphere Reserve by UNESCO and a World Heritage Site. Since 1988, 95% of the park has been designated wilderness by the United States Congress.<sup>22</sup> The region has been home to many Indian tribes, including the Hoh people who occupied the Olympic Peninsula and the area that is Hoh Rainforest. Traces of civilization's impact on the wilderness is evident in archeological sites that trace 12,000 years of human footprints.<sup>23</sup> The true history of Olympic National Park is found in the old-growth forests and biologically rich understory's that cover acres of untrammeled territory. The sheer mass and opposition of the 20 story canopies and 25ft wide trunks are an imposing visual reminder of some of earth's first organic inhabitants.

## Climate

As storm clouds from the ocean move into the foothills and valleys and up the Olympic mountains, the cold air and air pressure pouring almost 12ft of rain on the forests every year.<sup>24</sup> The mild temperatures average between 70-80 degrees in the

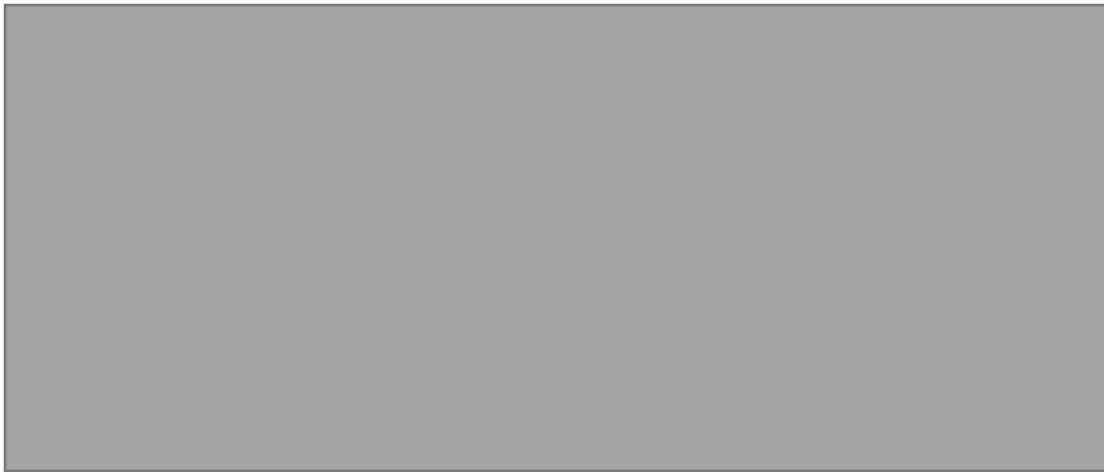
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<sup>22</sup> Wilderness Connect. "Connecting federal employees, scientists, educators, and the public with their wilderness heritage."

<sup>23</sup> "Olympic," History & Culture, accessed May 2017,  
<https://www.nps.gov/olym/learn/historyculture/index.htm>

<sup>24</sup> "Olympic," Weather and Climate, September 2015, accessed May 2017,  
<https://www.nps.gov/olym/planyourvisit/upload/weather.pdf>

summer and 40-50 degrees in the winter.<sup>25</sup> Like Glacier Bay, Alaska, warm winters are contributing to retreating glaciers and thinning ice on the Olympic mountains, impacting rainfall and subsequently, the vegetation and wildlife of the forest. Summer droughts are not uncommon; however the trunks and canopies of the coniferous and deciduous trees help capture rainwater and sustain the lower plants and animals during the dry spells.<sup>26</sup>



**Figure 13 - Hoh Rainforest monthly temperature graph** (*weather.com*)

The sun's path over the Olympic peninsula is shallow in the summer, leading to 17 hours of sunlight in the middle of July. In contrast, the winter months get half the amount of solar exposure throughout the day.<sup>27</sup> With the dense canopies of the temperate rainforests, daylighting can be shortened even further in more highly vegetated locations.

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<sup>25</sup> Western Regional Climate Center, accessed May 2017, <http://www.wrcc.dri.edu/>

<sup>26</sup> "Olympic," Discover Olympic's Diverse Wilderness, accessed May 2017, <https://www.nps.gov/olym/>

<sup>27</sup> National Oceanic and Atmospheric Administration, accessed May 2017, <http://www.noaa.gov/>



**Figure 14 – Sunrise, sunset, dawn and dusk times, graph** (*gaisma.com*)

**Figure 15 - Sun Path Diagram** (*gaisma.com*)

**Figure 16 - Sunrise, sunset, dawn and dusk times, table** (*gaisma.com*)

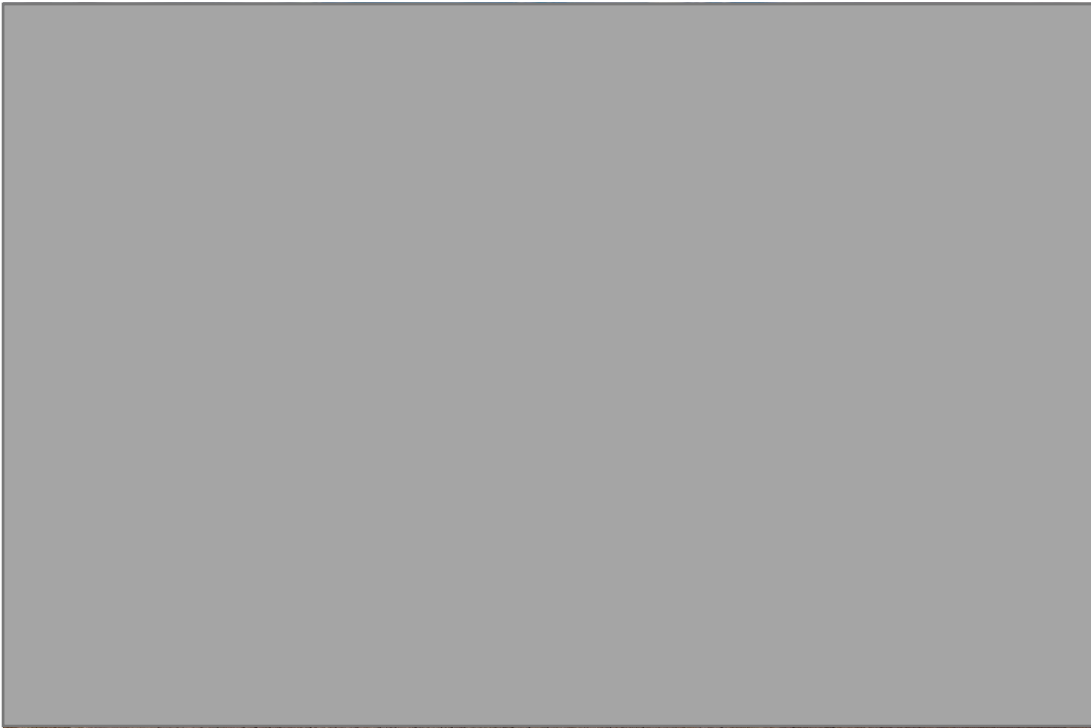
#### Environment / Ecology / Vegetation

The environment in the Pacific northwest is shaped heavily by weather and climate conditions. The generous amounts of precipitation has a great impact on the vegetation and wildlife. From the high elevations of the mountains, where the subalpine Forests are battered with high winds and heavy snow, to the low elevations of the temperate rainforests whose growth and greenery rely on the rainfall. These saturated climates form rich ecologies, providing important data towards

understanding how civilizations impact on the environment is shaping the wilderness condition.

Vegetation through the region changes with the elevation. In the temperate rainforests, Western Hemlocks, Douglas-firs and Sitka spruce trees are abundant, blanketed in moss and ferns that cover the forest's understory. Much of the old growth forests are found in the lowland and coastal areas, where the soil is deep and the coniferous canopies can reach 30 stories high.<sup>28</sup>

*Petrified Forest National Wilderness Area*



**Figure 17 - Blue Mesa, Petrified Forest National Park** (*NPS photo*)

Designated as protected wilderness in 1970 by Congress, the Petrified National Wilderness Area is located in eastern Arizona. What used to be a floodplain, this 50,000 acre wilderness is now a hot, dry tableland. Covered in tall, pine-like trees

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<sup>28</sup> Olympic National Park, "Olympic."

over 200 million years ago, the area is now littered with petrified wood, giving credence to its name.<sup>29</sup> The environment is known for high winds, frequent thunderstorms, and hot daytime temperatures that rapidly cool in the evening.<sup>30</sup> The fluctuating climate and sporadic weather conditions provide opportunity for an architecture uniquely suited to its evolving environment.

## History

Evidence discovered by archeologists on site suggest that inhabitants occupied the area over 8,000 years ago. The dry climate pushed residents to areas with more reliable water sources, but traces of their architecture remain. In the process of this migration from unfertile soil, single-family pueblos were substituted for large multi-room pueblos that could possibly house up to 200 occupants. Up to 100 single-story rooms were situated around an open plaza. Residents would access these rooms by ladders that descended a hole in the ceiling.<sup>31</sup> These structures offer ancient examples of architecture formed out of necessity due to inhospitable climate conditions. Traversing the landscape, one can see the traces of the climates impact on the natural environment through the petrified fossils, painted desert, and wind worn rock formations.

## Climate

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<sup>29</sup> Wilderness Connect. "Connecting federal employees, scientists, educators, and the public with their wilderness heritage"

<sup>30</sup> "Petrified Forest," A Place for Discovery, accessed May 2017, <https://www.nps.gov/pefo/index.htm>

<sup>31</sup> Anne Trinkle Jones, *Stalking the Past: Prehistory at Petrified Forest*, (Petrified Forest Museum Assn; First Edition, Sept 1993)

Temperatures in the area can fluctuate by as much as 40 degrees between day and night.<sup>32</sup> Apart from the sometimes frequent and fast-moving thunderstorms, the skies are usually clear, releasing any heat gained during the daylight hours into the atmosphere at night. On average during the summer months, the temperature reaches mid-nineties during the day and drops to between 50-60 degrees in the evening. According to the Weather Channel website, in the winter, temperatures average around 50 degrees during the day and drop as low as 21 degrees at night. These conditions require careful planning and material selection as the need for thermal mass in the building is evident.

Just as the open skies affect the temperature in the region, the open landscape affects the elements and does not provide much protection from the wind. Sandstorms and dust devils are common, and wind speeds have been measured as high as 40-60 miles per hour during late winter and early spring. During the summer, there is a consistent 10mph wind that helps make the high temperatures more tolerable. Humidity is low, on average less than 50%, making it hot during the summer but not unbearable. Most of the rain falls during the summer months, with July and August contributing to much of the annual precipitation. It is rare to make it through the day without a passing thunderstorm, creating bursts of heavy rain, lighting, and sometimes snow or hail. Any precipitation that occurs is absorbed by the landscape, creating rich, natural colors in the saturated region of the wilderness known as the

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<sup>32</sup> "Petrified Forest," Weather, accessed May 2017, <https://www.nps.gov/pefo/learn/nature/weather.htm>



*Painted Desert.*<sup>33</sup> According to The Weather Channel website, Petrified Forest National Park receives on average, 9.6 inches of precipitation per year.



**Figure 18 – Climate data for Painted Desert region of Petrified Forest National Park (NOAA)**



**Figure 19 - Sunrise, sunset, dawn and dusk times, graph (gaisma.com)**

**Figure 20 - Sun path diagram (gaisma.com)**

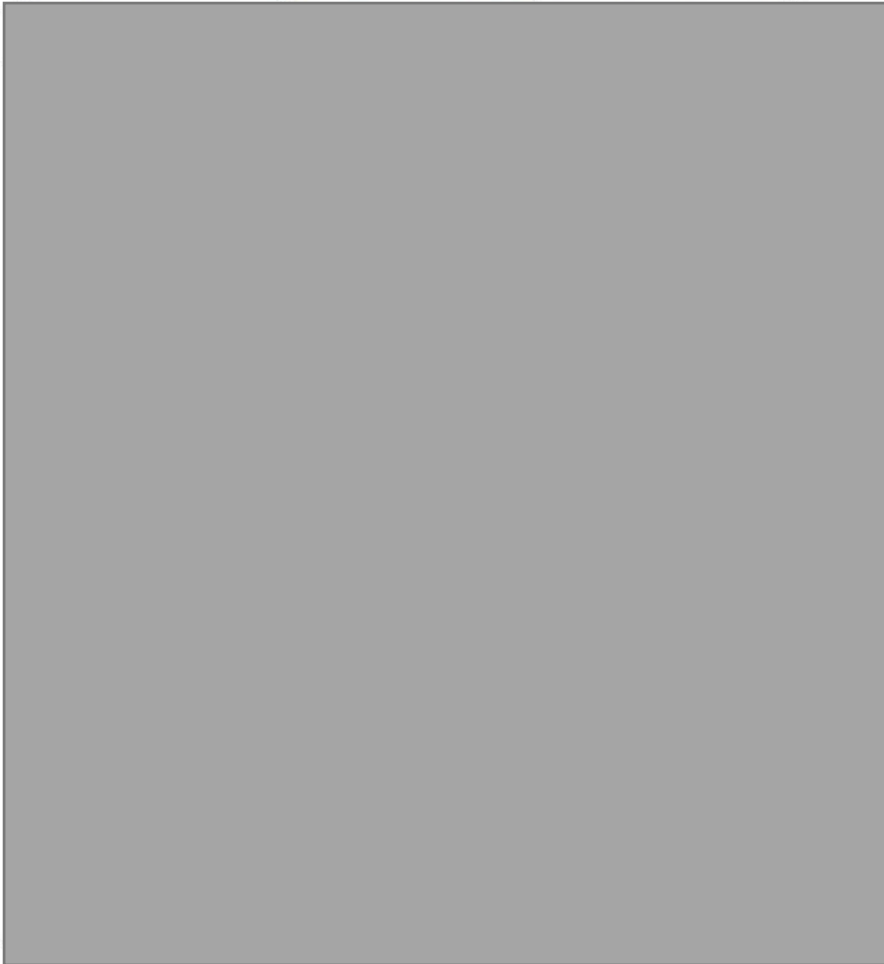
**Figure 21 - Sunrise, sunset, dawn and dusk times, table (gaisma.com)**

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<sup>33</sup> National Park Service, "Petrified Forest."

## Topography

The geography of the Petrified Forest is relatively flat in comparison to Glacier Bay and the Olympic Peninsula. At its lowest point, near the Puerco River, the elevation reaches 5,307ft and reaches up to 6,262ft at Pilot Rock. Much of the landscape is composed of rolling hills and eroded badlands. Most surface water and intermittent streams run south towards the Puerco River.<sup>34</sup> The higher elevations see more vegetation in contrast to the lower, semi-desert grasslands.



**Figure 22 - Topographic map of the Horse Mesa region of the Petrified Forest (USGS)**

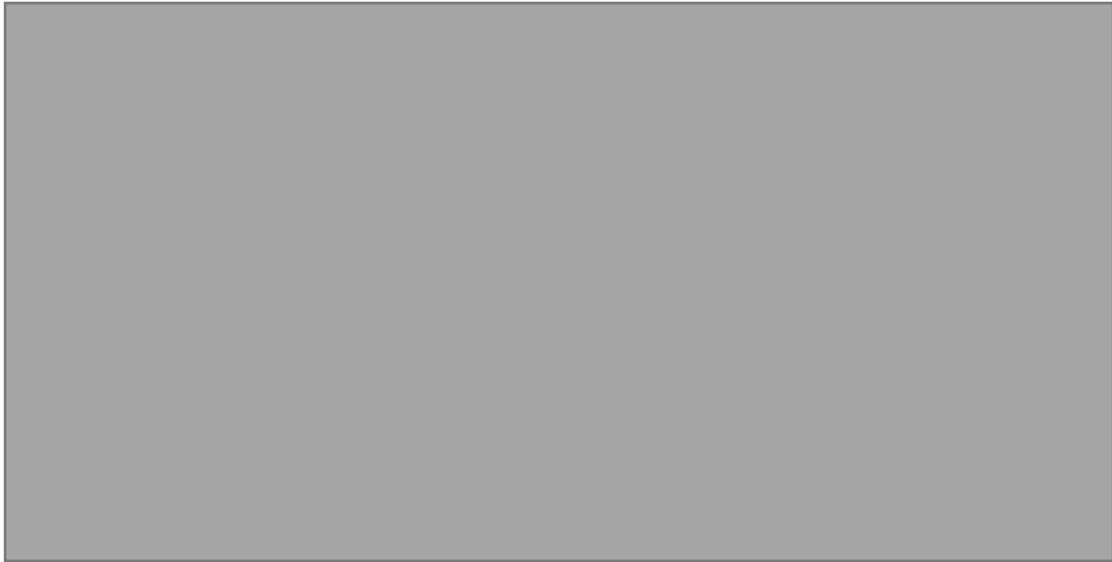
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<sup>34</sup> "Inventory & Monitoring (I&M)," Petrified Forest National Park (PEFO), accessed June 2017, <https://science.nature.nps.gov/im/units/scpn/parks/pefo.cfm/>

## Environment / Ecology / Vegetation

The most abundant species of vegetation in the region is grass, with over 100 different species. Trees and thicker vegetation can be found near the rivers and locations receiving more water.

### Everglades



**Figure 23 - Everglades National Park** (*photo by Jupiter Images*)

## History

Before the Everglades were officially classified as a wilderness location, early colonial settlers attempted to drain parts of the wetland to use for farming and communities. The area was viewed as inhospitable swampland and extensive dredging was undertaken to try and gain more land for development. By the 1900's small communities formed in the area, sustaining a living by farming and living in shacks raised off the damp ground. During this time, the area was seen as extremely unpleasant, even to naturalists such as Leverett White who visited the town of

Flamingo in southern Florida in 1893 when he claimed to see “an oil lamp extinguished by a cloud of mosquitoes”.<sup>35</sup>

This is to say that civilization’s attempts to inhabit the Everglades was challenging and often unsuccessful. In 1947, the Everglades were declared a protected wilderness area so further damage to the area could be prevented.<sup>36</sup>

#### Climate

The tropical climate characterizes the Everglades climate. During the summer, the air is damp and there are heavy amounts of rainfall. 70% of the annual rainfall occurs during the summer months. The dry season comes in the winter, with much less precipitation. The average temperature change between summer and winter is minimal, with a roughly 20 degree drop in temperature during the winter.

Part of what is so interesting about the Everglades climate is just how much water comes and goes from the area during the year. The area is directly sustained by the atmosphere through Evapotranspiration, the sum of all of the evaporation from ground level to the atmosphere. The evaporated water from the surface creates thunderstorms that move around the region and contribute to the cycle that sustains the watershed. In the wet season, these thunderstorms are common because of the sun heating the ground causing warm, damp air to rise that turn into storms in the afternoon. Much of the rainfall happens towards the end of the wet season around August and September. With the eastern coast of southern Florida receiving the most

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<sup>35</sup> “Everglades,” Developing the Everglades, accessed June 2017, <https://www.nps.gov/ever/learn/historyculture/development.htm>

<sup>36</sup> “Everglades,” History and Culture, accessed June 2017, <https://www.nps.gov/ever/learn/historyculture/index.htm>

amounts of annual rainfall, the everglades can receive anywhere from approximately 40-60 inches of rain per year.

What makes the Everglades so interesting for this thesis is the way in which the area so directly affects the climate of the region in a visceral way. The interaction between ground water and the atmosphere is obvious from a sensory standpoint. The feel of the hot humid temperature on your skin, the smell of damp cold air as a storm approaches, the visual and auditory result of heavy rainfall that may only last for a short period of time. How that ebb and flow can influence architecture is something that could really connect a building to place.



**Figure 24 - Sunrise, sunset, dawn and dusk times, graph** (*gaisma.com*)

**Figure 25 - Sun path diagram** (*gaisma.com*)

**Figure 26 - Sunrise, sunset, dawn and dusk times, table** (*gaisma.com*)

## Topography

Elevation is 0 to 8 feet.<sup>37</sup> Geologic shifts taking place over millions of years formed the south Florida landscape with limestone bedrock. The Everglades that you see today was formed by a process of erosion, compaction, and weathering that shape the geology and hydrology of the environment.<sup>38</sup>

## Environment / Ecology / Vegetation

The everglades are a region of tropical wetlands that comprises several ecosystems. The boundaries between these ecosystems can be identified by subtle changes in the vegetation if at all. The area is divided up into the area of Hardwood Hammock, Pinelands, Mangrove, Coastal Lowlands, Freshwater Slough, Freshwater Marl Prairie, Cypress, and Marine and Estuarine.



**Figure 27 – Vegetation and water levels in Everglades ecosystems** (*drawing by USGS*)

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<sup>37</sup> "Everglades," Everglades Park Statistics, accessed June 2017, <https://www.nps.gov/ever/learn/news/parkstatistics.htm>

<sup>38</sup> "Everglades," Geology, accessed June 2017, <https://www.nps.gov/ever/learn/nature/evergeology.htm>

The Pinelands are comprised of forests of slash pine trees that root directly into the limestone.<sup>39</sup> Characterized by tall slender trunks and high canopies, the area beneath the trees gives way to a variety of flora. One challenge in the Pinelands is that fire is a common and important part of the ecosystem. The plants here adapt to life with frequent fires, could a building?

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<sup>39</sup> "Everglades," Ecosystems: Pinelands, accessed June 2017, <https://www.nps.gov/ever/learn/nature/pinelands.htm>

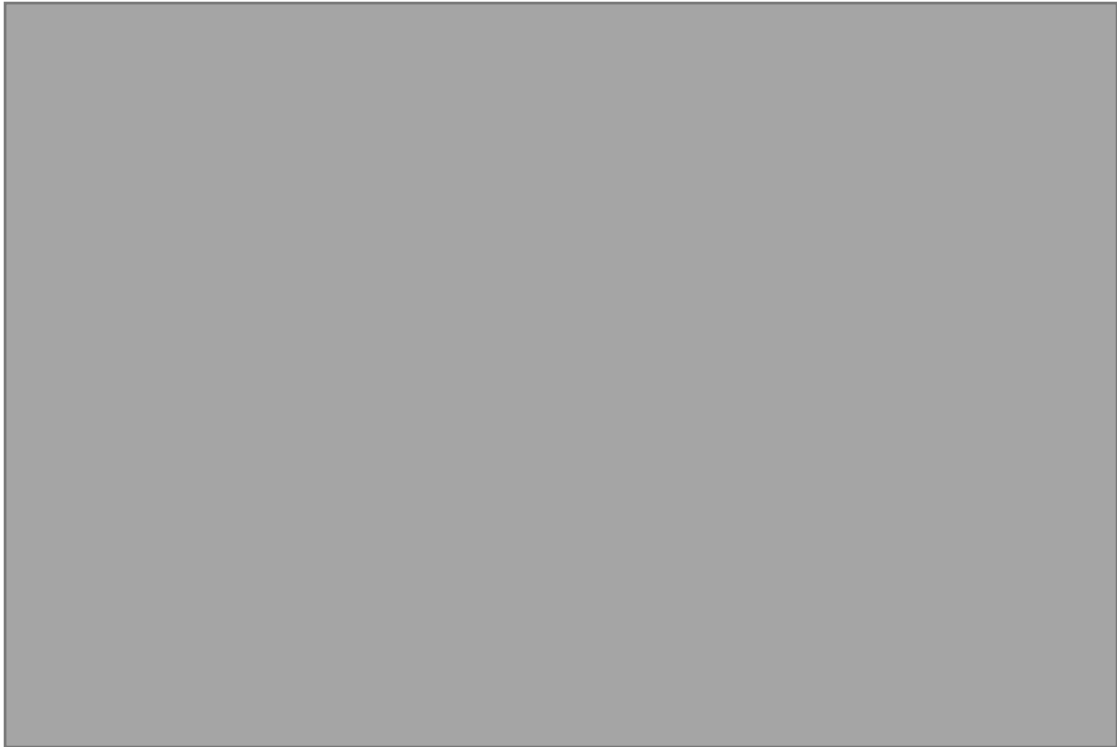
## Chapter 4: Site

### Site Description

The site for this thesis is the University of Maryland's Horn Point Laboratory located on the Eastern Shore in Cambridge, Maryland. The Horn Point Laboratory is part of the University of Maryland's Center for Environmental Science network, with students, faculty, and researchers working on a variety of environmental research including: climate and energy, coastal and estuarine science, environmental chemistry and toxicology, ocean science, genes and microbes, fisheries and aquaculture, terrestrial ecology and land management, and water resources and watersheds.

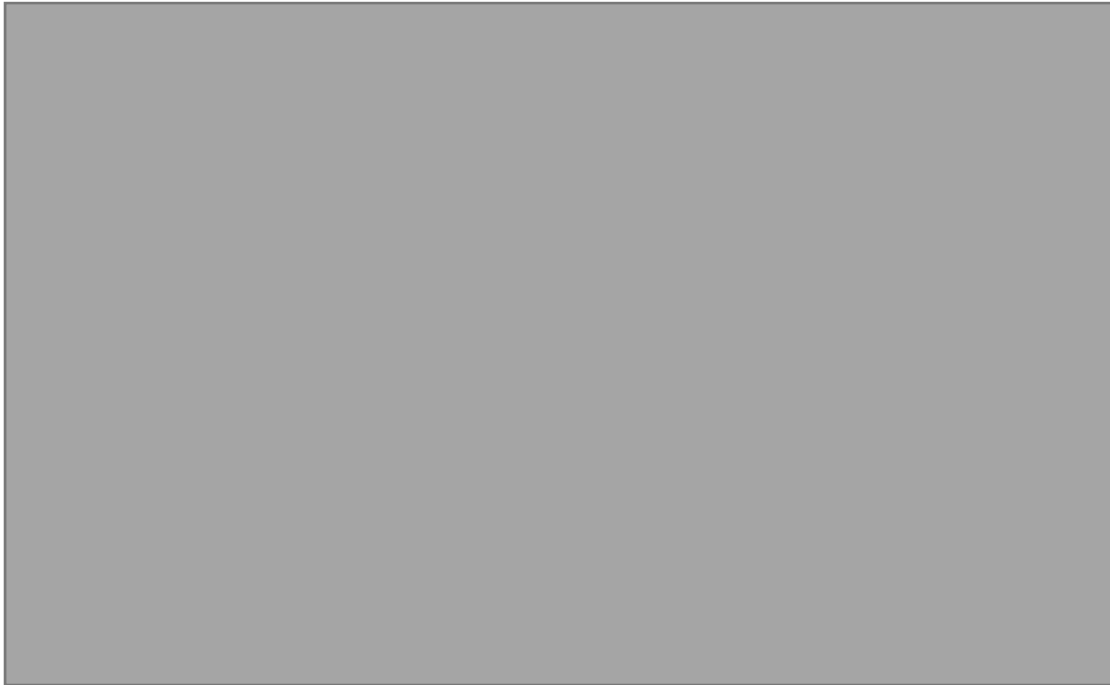
The Horn Point laboratory site falls under the middle landscape definition of wilderness. It is an area on the outskirts of civilization that blurs the line between nature and society. These middle landscapes are areas where we find moments with which we feel as though we are isolated from human control, but that influence is just minutes away. At the local scale, the site walks a fine line between the built environment of the main part of campus, and the natural environment that surrounds the infrastructure. It is a microcosm of the opposition between wilderness and civilization, offering opportunities to not only analyze how we build in each of these environments but move between them as well.





**Figure 28 - Location of site in relation to Washington D.C. and the University of Maryland**  
(*Google Earth*)

Located 90 miles outside of Washington D.C., the site is approximately a two-and-a-half-hour drive outside the nation's capital, a primary hub of civilization in the mid-Atlantic United States. A closer look shows the site located just 9 miles outside of downtown Cambridge in a rural area that is surrounded by single family residential and agricultural land.



**Figure 29 - Location of site in relation to Cambridge, MD (*Google Earth*)**

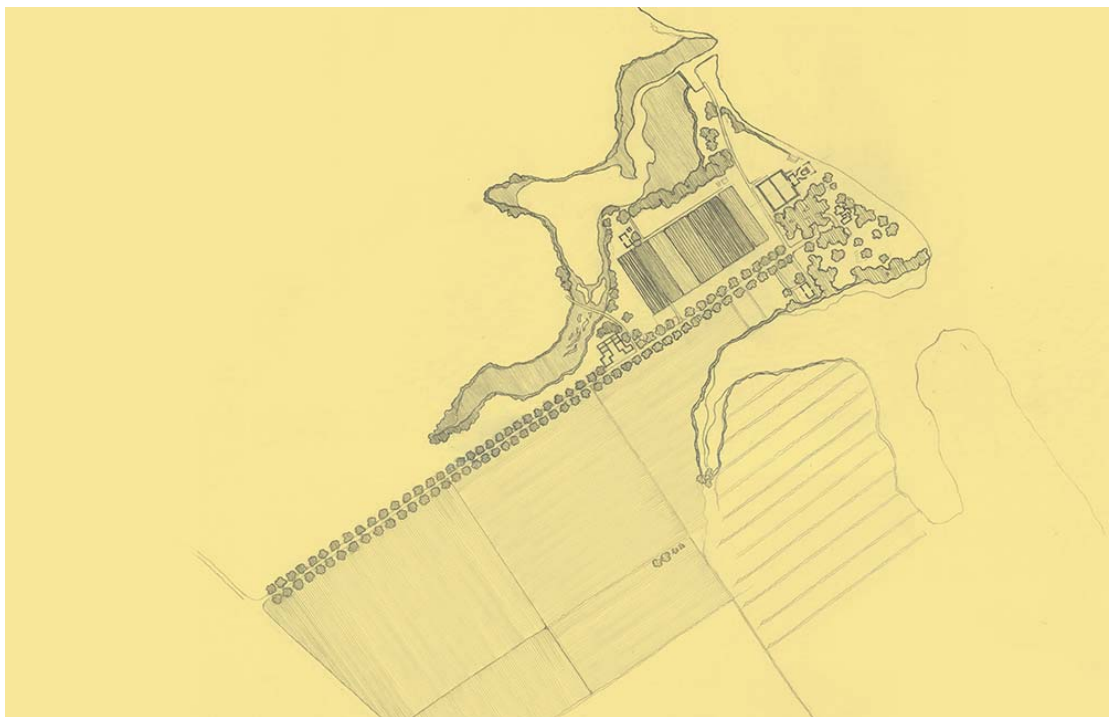
### *Site History*

The Dupont family once owned the site before it was turned over to the University of Maryland. The site was used for agriculture, like many of the other properties in the area. The classical organization of landscape characterizes the site. The entrance of the site is lined by an allée of trees that flank the main road through the property. This road is on axis with the Dupont residence that sits at the end of the main drive, with views out over the Chesapeake Bay. A recreational building was located northwest of the Dupont residence, with a small classical garden placed behind the structure. The human impression on the land can be seen in the manicured fields to the south of the Dupont residence, none more obvious than the irrigation

canals that can be seen on the peninsula just west of the residence.



**Figure 30 - Historical aerial of the site taken some time between 1920-1940** (*photo provided by UMCES and Horn Point Laboratory*)



**Figure 31 - Interpretation of possible site plan during Dupont ownership of the site** (*drawing by Author*)

### Site Analysis

The site consists of 800 acres, 400 of which is within the primary boundary of the campus where the main buildings are located. At a glance, the site can be seen to contain patches of buildings that are surrounded by vast amounts of vegetation.

#### Circulation/Access



**Figure 32 - Circulation on site** (*drawing by Author*)

The site is organized around the main drive, a long straight road that is on axis with the old Dupont residence. Both vehicular and pedestrian traffic occur on the same roads with no sidewalks or designated areas that separate the way cars and people move through the site. Remnants of the allée that was present when the Dupont family owned the site are visible in the sporadic spacing of trees that are left lining the main drive. These trees offer very little cover from the weather, leaving any pedestrian movement exposed to the elements. A visit to the site shows that many of

the people who work on site travel from building to building in cars rather than walking, even if it is only two-minute drive.

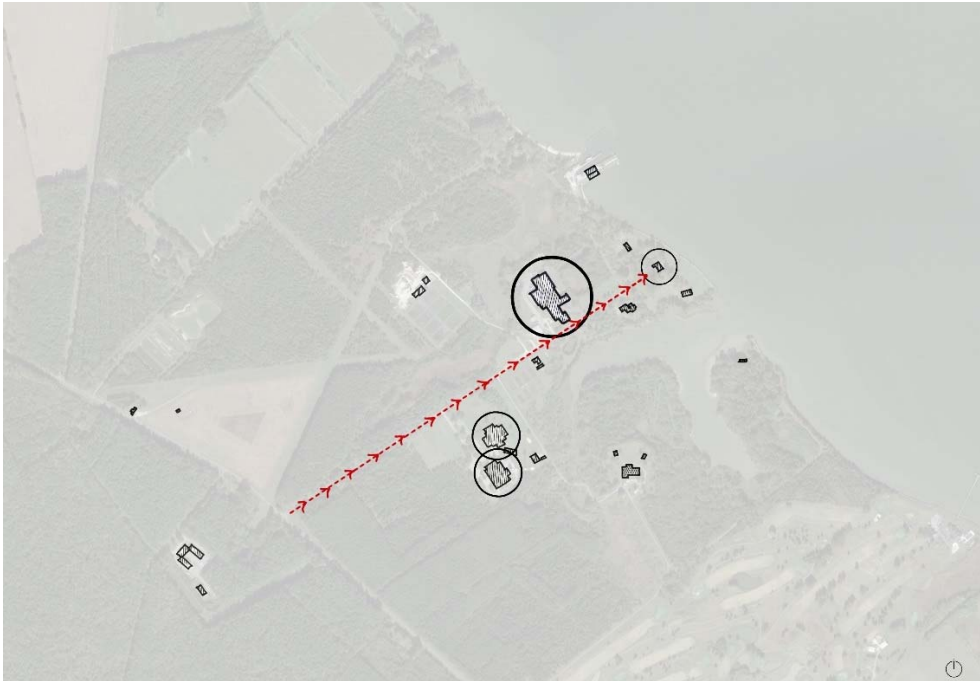
### Building Types



**Figure 33 - Building Programs** (*Drawing by Author*)

The buildings on site can be divided into six different programs; recreation, laboratory, administration, facility, institutional, and a dormitory. The buildings are organized rather sporadically, without a clear strategy to their placement. Much of the

built environment is focused around the primary road in the center of the property, with only a few outliers that are placed closer to the edges of the site.



**Figure 34 - Organization of buildings along the central road that runs through the site** *(drawing by Author)*



**Figure 35 - Built environment clustered in the center of the site, surrounded by vegetation** *(drawing by Author)*





**Figure 36 - West facing facade of Dupont residence and current administration building** (*image by Author*)



**Figure 37 - South facing facade of AREL laboratory building** (*image by Author*)

The education center is one of the few buildings on site whose primary users are people off-campus. The education center provides a location for K-12 students to visit the site, learn about the environment, and camp overnight. It houses a classroom, gathering space, kitchen, and dining space. Two smaller dormitory cabins are located behind the education center, each with bunkbeds to sleep approximately forty students between the two cabins. The location of the education is such that it is separated from a majority of the buildings on site, leaving it isolated and out of sight for anyone visiting the campus. The isolated nature of the building is a benefit for creating a camping-like experience in the woods, however, it seems often neglected because of its location. Given its use is primarily in the summer, for most of the year the building goes unused and unnoticed.



**Figure 38 - Isolation of Education Center** *(drawing by Author)*





**Figure 39 - (right) Dormitory cabin behind education center** (*image by Author*)

**Figure 40 - (left) Southern Facade of Education Center** (*image by Author*)

## Topography



**Figure 41 - Topography of the site** (*drawing by Author, data provided by Dorchester County Planning and Zoning*)

Topography across the site can be characterized as being flat, with the highest point being just 12ft off the water near the Dupont residence building. The south-eastern peninsulas are 8ft and 10ft off the water.

### Hydrology

One of the most fascinating features of the site is the way water is used and moves through the site. The natural conditions that form the peninsulas are juxtaposed by the artificial ponds and pools made for scientific research. The regimented patterns of the research pools contrast the organic movement of the natural water.



**Figure 42 - Hydrology of the site** (*drawing by Author*)

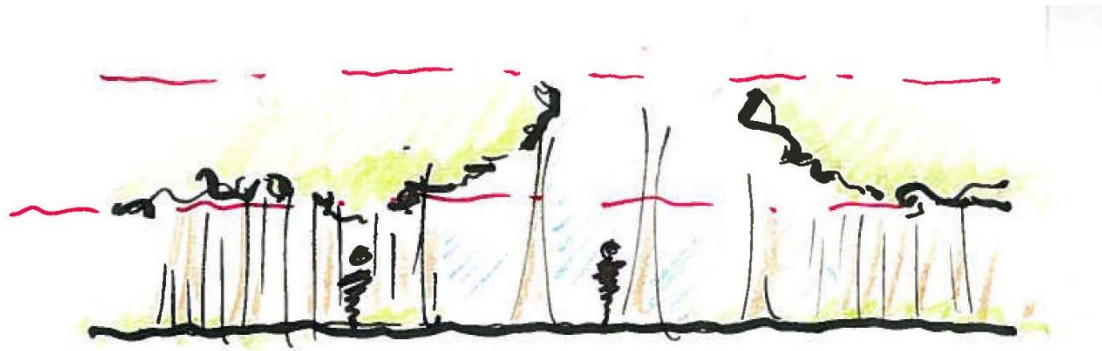
### Observation and Abstraction of the Natural Environment

There are many parallels that can be found between the way nature forms spaces in the environment and the design techniques architects use to create space. The heavily

vegetated portions of the site have characteristics that can be extracted and used in the design process to inform the building. The way light filters through leaves, the transparency in a grove of trees, the various heights of tree canopies, the color palette of different shades of green, brown, grey, and red – these features are abundant on site and analyzing the ability to capture their essence can help connect the building to place.



**Figure 43 - Abstracting design queues as it relates to the various levels and types of vegetation scene on site** (diagram by Author)



**Figure 44 - Expansion and contraction of vegetation on site** (drawing by Author)





**Figure 45 - Vegetation framing views to the Chesapeake Bay** (*image by Author*)



**Figure 46 - Natural hallways created by arched canopies through the site** (*image by Author*)





**Figure 47 - Water carves its way through tall grass** (*image by Author*)



**Figure 48 - Benches with views out over the bay on the tip of the north-eastern peninsula** (*image by Author*)

## Chapter 5: Program

### *History and Social Considerations*

In the world today, opposition between wilderness and civilization is not defined by expansion and settlements, it is based in science. The remaining untrammeled areas of the United States are protected from settlement, however the debate over the necessity of that protection is constant. Proponents for the protection of the environment argue they're fighting a lost cause. As dwindling resources and an increasing reliance on fossil fuels persist, the politics of environmental protection is becoming increasingly convoluted. Civilizations' footprint on the earth has raised concerns with scientists across many professions and is particularly focused for climatologists. Some experts argue we are at the precipice of human habitation and action must be taken to mitigate further destruction of our environment. In the battle for nature there are two camps, those who doubt the impact of a changing climate and those who warn of greater change to come. In the United States, these opinions fall along party lines.



**Figure 49 - Spring 2015 Global Attitudes Survey. Q32, Q40, Q41 & Q42** (*Pew Research Center*)

Whether you believe climate change is real or not, there is a strong argument for understanding how our planet is evolving as key to sustaining civilization over future generations. To develop this understanding of our world, scientists, researchers, and students alike, should be provided environments that can facilitate their field of study without removing them from the natural world. Environmental Science campuses often engage this research in built environments that lack a strong connection to nature. Ideal circumstances for research on the environment would provide facilities that provide adequate program to enable the study of these topics without entirely removing the researchers from natural conditions.

In the study of nature and the environmental sciences, it is important that the architecture of these facilities not only suit the needs of the researchers from a practical, scientific standpoint, but from a livability and comfort perspective as well. These challenges provide opportunities for architects to learn from the design process that comes with building in extreme climates while maintaining the character and quality taken with buildings in other locations. Buildings should enable dwelling that

responds to the natural and climatic conditions of the site as to be better connected to those environments, limiting the barriers that remove the inhabitants from the outside world.

### *Program Objectives*

To address the lack of qualitative architecture that responds to its natural context, this thesis proposes an architectural solution that bridges and enhances the connection between humans and nature. By rethinking the way architects build in natural environments, a more comprehensive approach to building can be developed. An approach that is focused on designing each dwelling according to the natural conditions of the site, better integrating inhabitants with their surroundings and increasing the quality of living. The buildings proposed in this thesis are tailored to respond to the specific human and natural conditions of the site, partly influenced by historical vernacular architecture that hold early precedent for efficient buildings shaped by their environment.

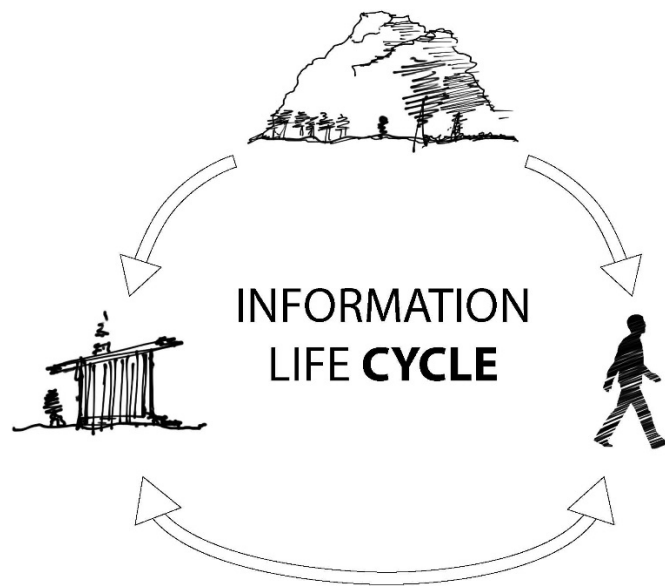
The buildings proposed in this thesis provide lodging and work areas for students, faculty, and researchers, enabling seasonal and year-round habitation for studying the environment. The flexible nature of these spaces would service people of different academic backgrounds and age groups, providing the same experience for each. The institutional nature of the site would require the program to adequately provide not only living quarters, but areas for study and reflection as well.

The local topography and climatic conditions of the site determine how the program will be executed through the architecture; whether the dwellings are comprised of one building with multi-use spaces or a series of buildings that divide



the program into separate, dedicated structures. The importance of building form, location, and orientation to address issues of sun exposure, wind, and precipitation will dictate the final organization of the program.

The success with which the architecture addresses the programmatic requirements on site can inform which building practices are most effective in reducing energy consumption and providing living conditions that are designed around the human scale and human's relationship to the landscape. The vessel itself becomes a tool for study, helping to enhance the connection to the environment while informing new building techniques and practices for architectural design. The instructive relationship between humans, landscape, and building can be cyclical, each reacting to the other.



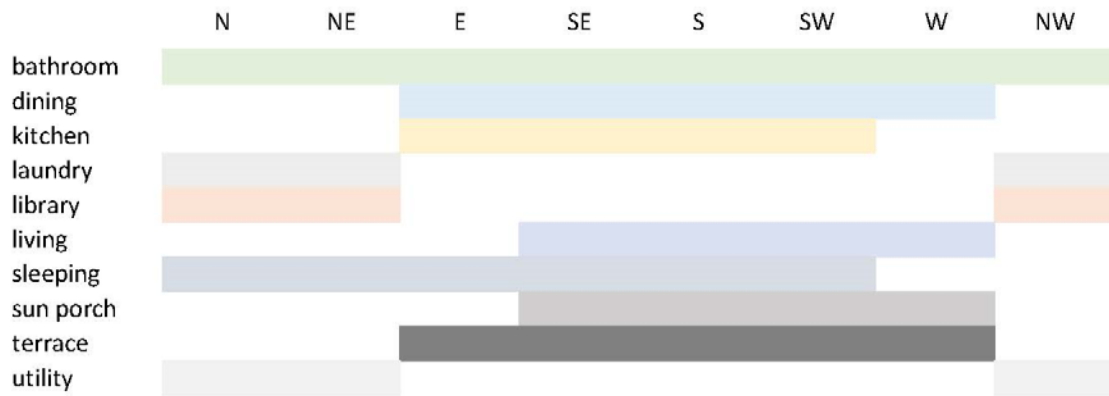
**Figure 50 - The information life cycle** *(diagram by author)*

As seasons change, the program can change also. Consider a versatile cabin that can transform storage space into sleeping quarters for more visitors during busy seasons

without limiting the experience of the residents. The flexible nature of the program can reduce the need for excess space and structures that may only be used during certain times of the year. Designing efficient spaces reduces the civilized footprint, limiting the impact of the building's presence on the site and providing inhabitants with total immersion into the landscape.

### *Programmatic Design Research*

The sizes of structures we build in the landscape is an important consideration for dwelling. With endless space and possibilities surrounding the dwelling, knowing what size each building should be can be challenging. Ultimately, the program of each room should be considered in relation to the human scale. What are the spatial requirements for each room? How can the form of the building increase the size of a space without increasing its footprint in the process? These decisions can impact the site conditions and determine how the building is oriented in the landscape. In addition to considering the way each individual building is positioned in relationship to the landscape, as a group they must apply the same design principles. How these buildings are oriented to the sun, placed along the topography, and interact with the wind, are all important to the relationship between the built environment and the landscape.



**Figure 51 - Ideal sun orientation for program** (diagram by author, based on data by Victor Olgyay)<sup>40</sup>

Using permanent and multi-use dwelling spaces, the building(s) will adapt to the needs of the inhabitant. The flexible nature of an open floorplan can allow for greater customization and interaction with the architecture, resulting in the built environment changing to the needs of the dweller instead of the dweller changing to fit the requirements of the built environment.

In addition to lodging, the program should provide communal spaces that encourage interaction and facilitate gathering among inhabitants. Living quarters, outdoor spaces, and communal work areas introduce dynamism to what is otherwise a typically static program. These communal spaces encourage scientists, researchers, and students to engage with the natural environment as well as their peers.

### Program

The program for this thesis will provide dwelling for students, faculty, staff, researchers, and guests to the Horn Point campus. Current accommodations service 20 to 25 people in a single dormitory structure. At the moment, these units are in high

<sup>40</sup> Olgyay and Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism*, 62

demand as the number of daily visitors on site can reach up to 100 during the summer months. Many of the current faculty and staff rent rooms from houses off site in Cambridge, or commute from their homes in neighboring cities. This highlights a need for flexible housing units on site that can accomodate a variety of different users for various lengths of time.

To accomodate this need, a series of cabins will be introduced to provide shelter for a diverse group of inhabitants that allows for housing on site, removing the need for people who work and visit the site to find accomodations elsewhere. A mix of smaller studio cabins and larger professor's cabins services a variety of size and length of stay requirements. The flexible nature of these cabins removes the need for specific structures to be built for individuals. Instead, the specific needs of certain individuals can be met simply with an adjustment in furniture.

The cabins are organized along a circulation spine that conencts both the studio and professor's cabins. The studio cabins are clustered in groups of three and organized around a communal outdoor living room. The professor's cabin serves as the head of the string and is adjacent to communal space that services all cabins along the circulation spine.

The studio cabins are 560sqft spaces with a gable roof that helps the structure remain compact without feeling cramped. The space is comprised of a kitchen and living room, bedroom, and bathroom, with a loft and storage space to compliment the primary rooms. The open floorplan allows for these spaces to be adjusted to fit the needs of the individual resident. Though these cabins will most often be occupied by students, graduate assistants, and researchers, they need to facilitate the requirements

of the community that visits the campus as well. The education center on campus brings in K-12 students from the community to learn and engage with the environment. The studio cabins can facilitate overnight visits for these students using twin beds in the bedroom and loft, housing a total of three students per cabin or nine per studio cabin cluster. As such, one string of cabins can accommodate up to 27 students, with the professor's cabin used for the guardians and chaperons.

The professor's cabins are 920sqft and designed to provide a housing solution that may be used for longer visits to the campus. They include a kitchen, living room, bedroom, bathroom, utility room with washer and dryer, and storage space. The cabin is designed with larger communal spaces to encourage engagement with the other cabin residents. The living room has a large gathering space around the hearth and accommodates a dining table that can service up to nine people. Across from the kitchen in a separate structure is a private study for the resident of the professor's cabin. This space provides a quiet reflection area and work space to allow for work to continue away from the primary residence and the built environment of the campus proper.

In addition to the studio and professor's cabins, each string of cabins is provided a study house and conference cabin. These structures are intended to provide quiet workspace within the natural environment. Although much of the work performed by the residents will take place in the laboratories in the center of campus, providing these spaces is important to enhancing their connection to the environment.

A significant part of the program for these cabins are the communal spaces that join them together. These communal spaces encourage the sharing of ideas and

help engage the residents in a community outside of their fields of study. These “outdoor living rooms” are anchored by a hearth that provides light and warmth, grounding the cabins in the environment and marking their place in the wilderness.

## Chapter 6: Precedents

In the quest for understanding how architecture can better serve the relationship between wilderness and civilization, it is hard to focus your attention to one area. How can architecture simultaneously provide shelter from challenging climates and foster comfortable living conditions that invigorate our senses and connect us to the landscape? Ultimately, how can architects reintroduce civilization to wilderness without influencing the natural environment?

The answers to these questions lie in building strategies already developed, with technology that already exists, and in cultures of people with the foresight to see their importance. The goal of these precedents is to not only inform the architecture through construction techniques and space-making but through the cultures and people whose lives have been connected to the environment for generations. To inform this thesis, the following chapter looks at the cultural influence of Scandinavia, the vernacular of early architecture that is shaped by climate, the architectural theory, and techniques of contemporary buildings.

### Scandinavia – Culture & Place

The countries that share the Scandinavian region, Norway, Sweden, Finland, Denmark, and Iceland, also share a unique appreciation for the environment and the conditions that shape it. In a region so connected to light, both spiritually and physically, inhabitants of these countries have traditions that celebrate the solar

conditions and encourage interaction with nature as evident from the midsummer festivals. At its core, the midsummer festivals are founded on the annual desire for people to share time with family, relieve stress, and reconnect with the environment.

*“Retreating to the countryside is about more than just taking a well-deserved holiday, it’s about maintaining work-life balance, tuning into nature, rest and restoration. Call it Nordic Zen.”<sup>41</sup>*

The midsummer festivals vary slightly from culture to culture, but each celebrate the longest day of the year. For northern countries, the celebration is accentuated by the 22 hours of sunlight that go along with the July date. However, during the winter the days are subsequently short, creating a sense of appreciation and urgency to absorb the sun while you can.<sup>42</sup> According to the Ministry of Foreign Affairs of Finland and Statistics Finland, there were approximately half a million official summer cabins in Finland in December of 2012. Though there are claims that the number of cabins used as summer retreats is closer 1.5 million at least.<sup>43</sup> Many families have a cabin in the landscape where they immerse themselves in nature to relax and spend time with family. For many the immersion in nature is an important tool in relieving stress and finding balance between work and life.

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<sup>41</sup> “The Art of Finnish Cottage Life,” This is Finland, accessed June 2017, <https://finland.fi/life-society/the-art-of-finnish-cottage-life/>

<sup>42</sup> National Oceanic and Atmospheric Administration

<sup>43</sup> This is Finland, “The Art of Finnish Cottage Life.”



## Experimental House

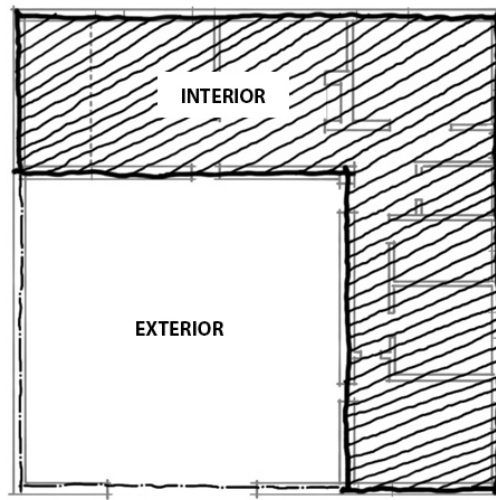
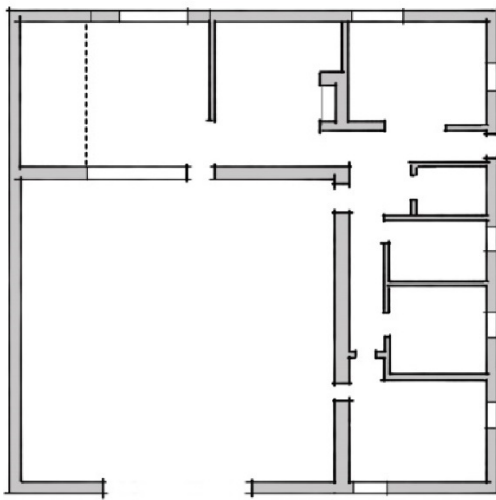
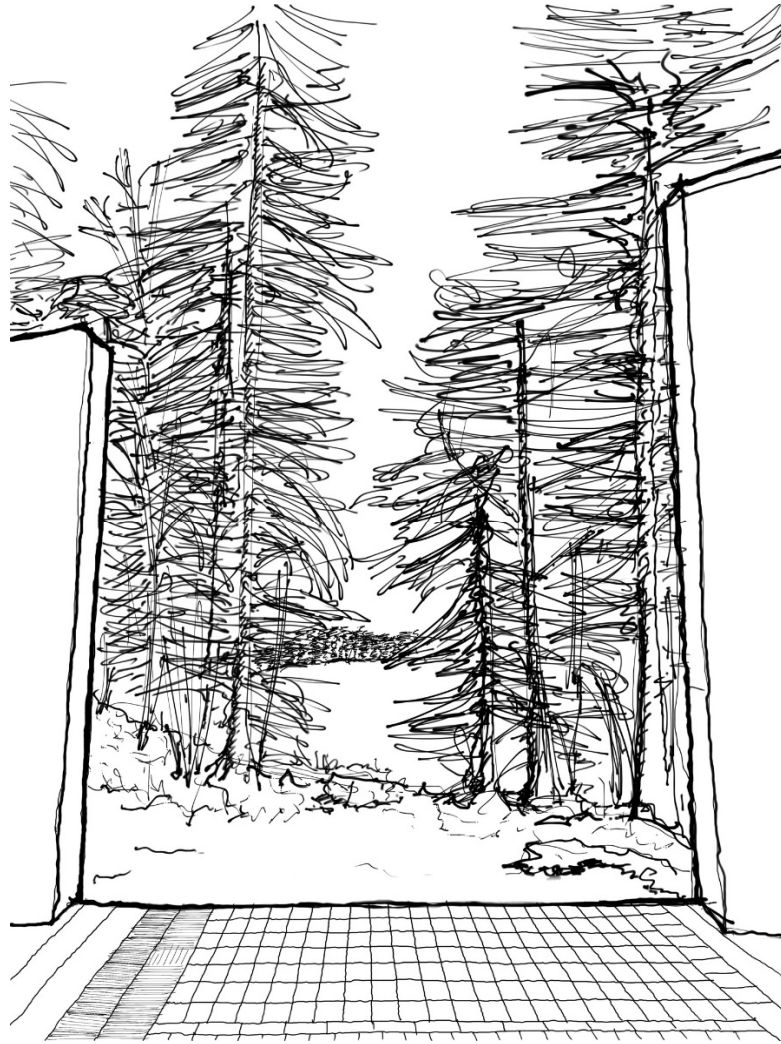


**Figure 52 - Approach to the Experimental House** (*photo by Author*)

**Figure 53 - Brick and tile in the courtyard of the Experimental House** (*photo by Author*)

Like many other Scandinavians, Alvar Aalto built a summer cabin in the wilderness to reconnect with the landscape. The Finnish architect was known for his functional designs that encompassed all aspects of the dwelling from structure to furniture and this project became a venue for him to explore new material, methods of construction, and architectural theory.

When it was first built in 1953, the house was only accessible via boat, absent of infrastructure and away from the grasps of civilization. Located in Muuratsalo, Finland, the house utilizes a courtyard scheme, the walls of which frame views to Lake Paijanne.



**Figure 54 - Walls of the courtyard framing the view of the lake** (*drawing by Author*)

**Figure 55 - Building floorplan of the Experimental House** (*drawing by Author*)

**Figure 56 - Delineation between interior and exterior space** (*diagram by Author*)

When walking through the heavily wooded area and up the small incline from the water, the house reveals itself to you like ruins in a forgotten landscape. The fragmented nature of the exterior walls is accentuated by the collage of various colors and sizes of brick and tile that shape its structure.

In the process of designing his summer cabin, Aalto created the “experimental” house. What influence did the privacy and freedom that the site provided have on the experimental quality of the project? Perhaps nature offered a blank canvas on which Aalto could test new materials and building technology, free from the restrictions of a built context. Aalto and the experimental house inform this thesis through the use of material, structure, and attention to detail. The courtyard scheme within the context of the landscape can begin to inform how architects define the building’s edge in surroundings with no true boundaries. The architectural freedom that nature provides is an opportunity to experiment with material and building strategies, especially those theories that are challenged by unique climate conditions.

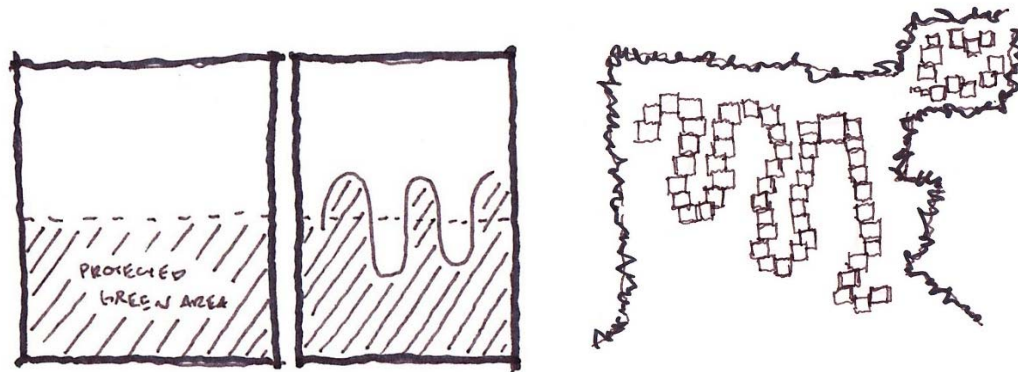
#### Fredensborg Houses



**Figure 57 - Fredensborg Housing. View towards landscape** *(photo by Author)*

**Figure 58 - View of courtyard from inside a home at the complex** *(photo by Author)*

The Fredensborg housing complex is a project by Danish architect Jorn Utzon, who worked with Alvar Aalto during part of his career and was one of many architects influenced by Aalto's work.<sup>44</sup> Located in Fredensborg, Denmark, the project was completed in 1963 as a housing complex for Danish citizens who lived in foreign countries in the service of Denmark.<sup>45</sup> The complex is comprised of a series of courtyard houses, each with the same footprint but varying in orientation. The houses appear strung together, reaching into the landscape like fingers on a hand. Together they form an intertwined community while maintaining privacy for each resident through the scheme of the building. The similarities with the Aalto's Experimental House in defining the private edge should be noted. Both architects capture exterior space within the walls of the building and begin to define the boundary of private outdoor space within a larger landscape context.



**Figure 59 - Organization of houses reaching into the landscape** (*diagram by Author*)

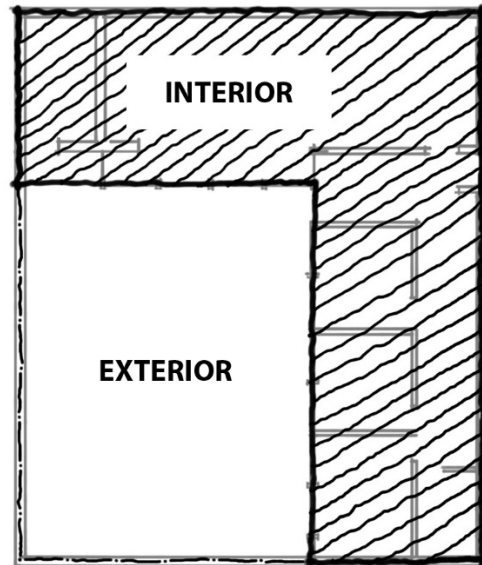
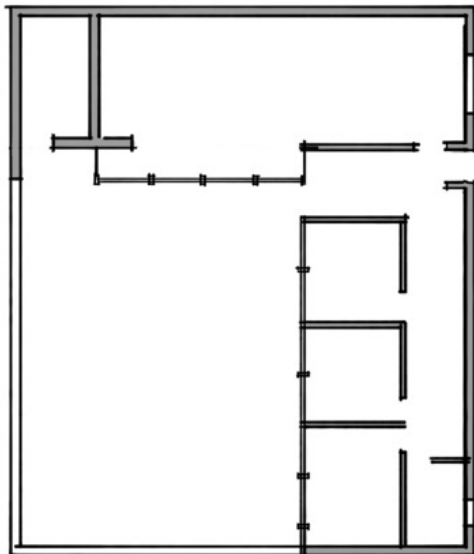
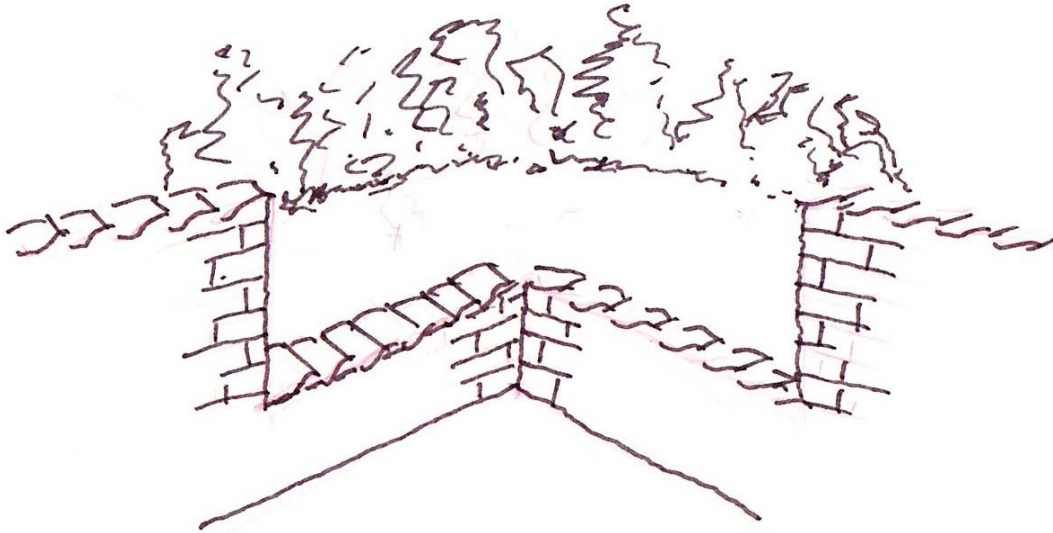
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<sup>44</sup> "Jorn Utzon," Biography, accessed May 2017, <http://www.pritzkerprize.com/2003/bio>

<sup>45</sup> "Fredensborg Housing," Project Description, accessed May 2017, <https://utzon.dk/portfolio-item/fredensborg-housing/>

Utzon's simple yet efficient building layout shows how buildings with a limited footprint can use exterior space to expand the program beyond the built architecture. The L-shaped floorplan packs the living quarters neatly into a manageable geometry and uses that form to shape exterior program space. When each building is brought together, the buildings' simplicity reduces cost through repetition while still allowing the flexibility to orient each residence according to the best solar exposure and view into the landscape.





**Figure 60 - Walls of the courtyard framing the landscape** *(drawing by Author)*

**Figure 61 - Floorplan of Fredensborg courtyard house Type-C** *(drawing by Author)*

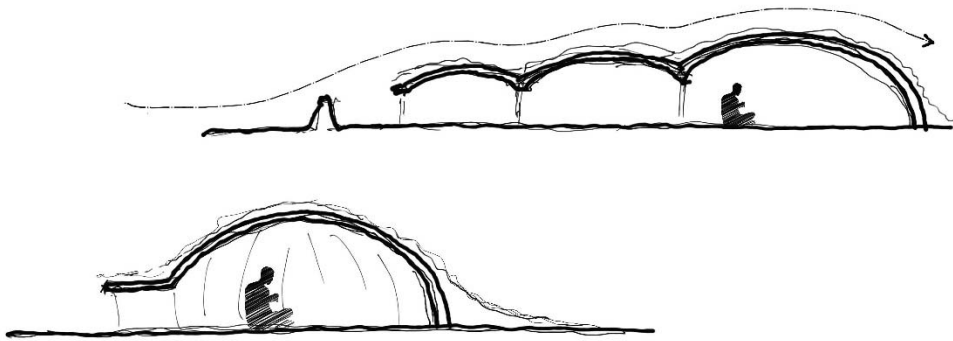
**Figure 62 - Delineation of interior and exterior space** *(drawing by Author)*

### Vernacular Architecture

Before the ease and efficiency of mechanical equipment discouraged architects from addressing a site's climate through passive strategies, architecture was shaped by the climate and weather of the site. Although new building technology is

vital in progressing architecture, we have become too reliant on mechanical systems to create comfortable living conditions. By combining new technology with historical building strategies, architects can create economic and energy efficient buildings that respond to the conditions of their location in new and inventive ways. When we look back at how primitive cultures created dwelling without electricity and complex construction tools, we can see examples of how architectural form and materials change and inform the structure in each of the climate extremes.

#### Cold Climates

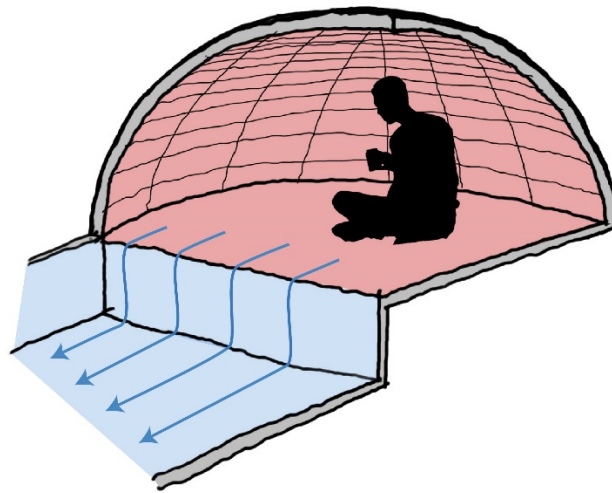


**Figure 63 - Igloo structure** (*drawing by Author*)

While the igloo can look like a pretty standard structure, it maximizes its efficiency in cold, arctic conditions. The dome shape shrugs wind off the roof, providing very little surface resistance and reducing the impact of the cold air on conditions inside. The structure is comprised of snow blocks, the inner surface is sealed by a thin layer of ice that forms from the radiant heat of the inhabitants and often a small lamp. To insulate further from the climate, the inside can be lined with

fur to limit heat loss.<sup>46</sup> The igloo offers examples of building strategies that are not only efficient, but that become more efficient when occupied. The building and the inhabitants are each strengthened by the others presence, creating a reciprocal relationship between man and architecture.

The dome shape is an ideal form for radiant heat that emanates from the body, trapping the warm air that is heated by the presence of occupants. The small tunnel at the entrance limits the cold air from affecting the living area in the back. In some cases, a wall just big enough to cover the entrance is built outside the tunnel, providing further protection from the wind. The living area is often raised above the circulation zone of the igloo, creating a cold-air sink that draws cold air away from the occupants and leaves warm air to heat the space being occupied.<sup>47 48</sup>



**Figure 64 - Heat sink draws cold air away from the occupants** (*diagram by author*)

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<sup>46</sup> James Marston Fitch and Daniel P. Branch, "Primitive Architecture and Climate," *Scientific American*, vol. 203, issue 6 (December 1960): 134-144

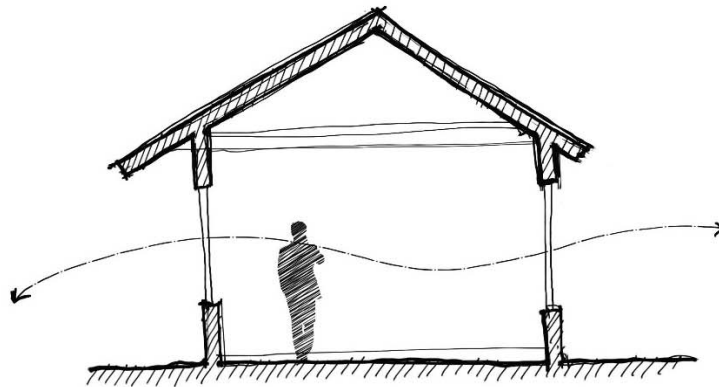
<sup>47</sup> Crowe, *Nature and the Idea of a Man-Made World*

<sup>48</sup> Olgyay and Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism*



The igloo is unique in the context of many of the primitive precedents in that it is a temporary structure. As a result, it is a structure that's conception has evolved out of necessity, as a response to survival in cold climates. In this regard, the igloo is rarely impacted by social or cultural influences, architecturally speaking, and helps identify simple building strategies that respond to cold environments.

#### Temperate Climates



**Figure 65 - Structure responding to temperate climate conditions** (*drawing by Author*)

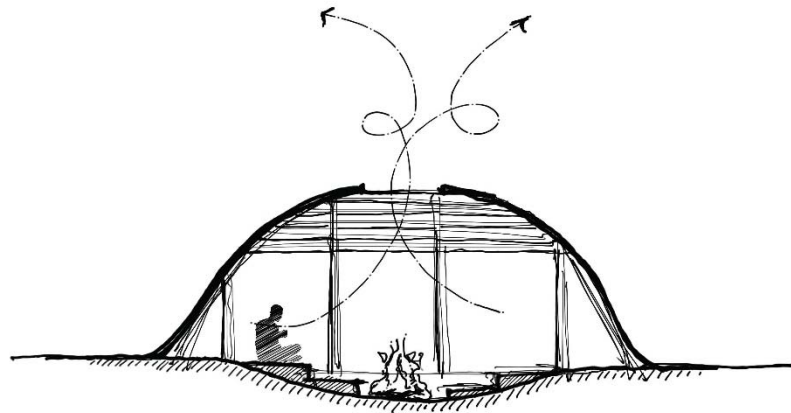
Where the igloo's conception is a direct result of the climate, primitive structures in temperate climates are shaped more by social and cultural issues than they are by climate. Where the climate provides more favorable living conditions, the architecture can begin to reflect other aspects of the weather and environment. Here issues of the microclimate such as rain or wind may begin to shape the architecture more than the temperature.<sup>49</sup> Northern temperate climates often see high rain precipitation turn to snow in the winter, causing early settlers and ecosystems to migrate with the seasons.

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<sup>49</sup> Olgyay and Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism*, 5

One primitive structure common to temperate climates is the Indian wigwam. Along the pacific coast, the wigwam dwelling was made from poles that were covered by animal skin that would protect inhabitants from wind and rain. A hole in the top of the wigwam would allow smoke to exit from a fire that would act as the primary heat source. The simple nature of the structures supported the mobility required of nomadic tribes in temperate climates who need to migrate south with the animals for winter.<sup>50</sup>

#### Hot – Arid Climates



**Figure 66 - Structure responding to hot-arid climate conditions** (*drawing by Author*)

The primary purpose of a structure built in a hot-arid climate is to provide shade from the heat of a glaring sun. In some parts of the world, large roofs and thick walls with good insulating properties, are used to reduce the number of peak hours' inhabitants are exposed to the sun each day.<sup>51</sup> As is typical with hot-arid climates, when the sun goes down the temperature drops significantly. To counter this, the thermal mass of the roof and walls absorb heat from the sun during the day, and

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<sup>50</sup> Olgyay and Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism*

<sup>51</sup> Olgyay and Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism*, 5

radiate that warmth into the dwelling at night when the air is cold. Structure's in this climate are normally oriented along the east-west axis, with a primary wall positioned to the southern sun that retains heat for the evening.<sup>52</sup> In the case of the Navajo Hogan, the structure's entrance would then open to the east, allowing the morning sun to warm the air in the building that cooled overnight.<sup>53</sup>

The inside of the Navajo Hogan was often dark, with the only light coming from a hole in the center of the roof. The hole was not only used as a light source but allowed smoke from the cooking fire to escape. This window to the sky has a utilitarian purpose in releasing smoke and providing light, but is also symbolic in that "the smoke hole is a link with the heavens, a constant reminder of the relationship between the world outside and the one within." – Norman Crowe<sup>54</sup>

The Pueblos and Hogans of the hot-arid climates highlight the importance for building materials to be informed by the environment and climate of the site. Materials with good insulation properties can limit the need for mechanical systems by mitigating the effects of changing outside temperatures on the inside of the structure.

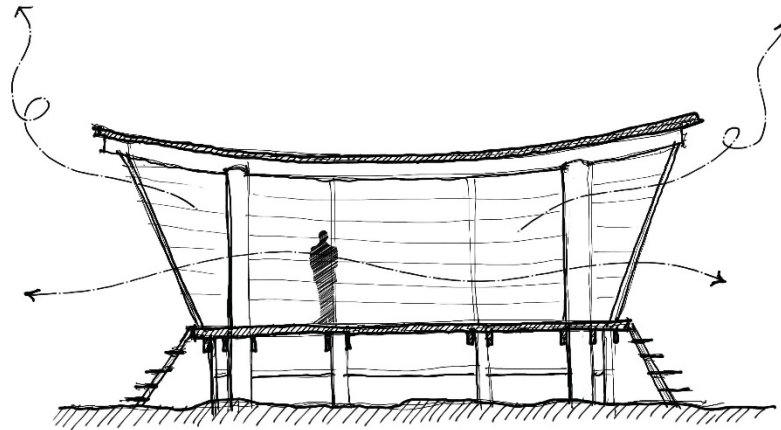
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<sup>52</sup> Olgyay and Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism*

<sup>53</sup> Crowe, *Nature and the Idea of a Man-Made World*, 36

<sup>54</sup> Crowe, *Nature and the Idea of a Man-Made World*, 38

## Hot – Humid Climates



**Figure 67 - Structure responding to hot-humid climate conditions** (*drawing by Author*)

Where the hot – arid climate was best suited by thick, insulating materials, the hot – humid climate is best suited by light, airy materials. Hot conditions year-round and consistent humidity along with consistent precipitation characterize the hot-humid climate. The structure's primary purpose is to keep the inhabitants cool and dry. To achieve this, these shelters often lift their inhabitants off the ground, removing them from the damp ground and lifting them into the breeze above. The roof is raised high above the floor, drawing warm air up and away from the living area.<sup>55</sup>

The importance on wind to cool inhabitants makes constructing several buildings on one site particularly challenging. Historically, tribes in southern parts of the world constructed their villages to maximize the effectiveness of the wind. By scattering the buildings on the site, the air is never obstructed by another building and each structure can ventilate efficiently.<sup>56</sup>

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<sup>55</sup> Crowe, *Nature and the Idea of a Man-Made World*, 38

<sup>56</sup> Olgyay and Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism*. 5

## Loblolly House



**Figure 68 - Loblolly House (left)**(Photo by Peter Aaron/OTTO)

**Figure 69 - Assembled from components fabricated off-site (right)**(Diagram by Kieran Timberlake)

*“Our desire in conceiving this home was to reimagine what was possible in the realm of building—with the intention to improve the productivity of design and construction, enhance affordability and quality, and do so in an ethical and aesthetically moving manner.” – Kieran Timberlake<sup>57</sup>*

The Loblolly house by Kieran Timberlake is a private residence located in Taylors Island, Maryland. The climate is on the border between temperate and hot-humid, with temperatures and humidity rising during the summer months. Completed in 2006, the Loblolly house is an off-site fabricated, single family home that gets its name from the loblolly pines that fill the site.<sup>58</sup> What makes Kieran Timberlake and this precedent so relevant to this thesis is the architect’s use of integrated assemblies

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<sup>57</sup> “Loblolly,” Kieran Timberlake, accessed June 2017, <http://www.kierantimberlake.com/pages/view/20/loblolly-house/parent:3>

<sup>58</sup> Kieran Timberlake, “Loblolly House.”

that are fabricated off site and designed to be easily assembled with hand tools on location. This functionality can allow for easier, more cost-efficient transport by reducing the amount of individual building materials needed on on-site.<sup>59</sup>

The pre-fabricated components are brought together by an aluminum frame that is situated atop wooden piers. These modular building strategies have been acknowledged for their ability to assist the building industry in recycling and reusing building materials by the Lifecycle Building Challenge competition that is sponsored by the United States Environmental Protection Agency.<sup>60</sup> These practices in turn reduce the energy required to produce new building materials, lowering greenhouse gas emissions, and reducing the building's impact on the environment. The functionality and environmental benefits associated with easily assembled and disassembled structures helps inform an important question to this thesis – how can architects build in the wilderness, enabling access to remote landscapes, while leaving no trace of man's presence on the land and ecosystem?

### Olson Kundig

*“I don’t think that I could ever design something as beautiful as what’s already out there. We’re here to frame the landscape, to create an experience of that place, and perhaps to bring some of that experience—the intimacy, the vulnerability— inside the house.” – Tom Kundig, Design Principal*

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<sup>22</sup> Kieran Timberlake, “Loblolly House.”

<sup>60</sup> Kieran Timberlake, “Loblolly House.”

At the scale of the buildings proposed in this thesis, Olson Kundig has produced several structures in remote landscapes along the west coast of the United States and across the globe. More specifically the projects Delta Shelter, The Pierre, Chicken Point Cabin, and Sol Duc Cabin, all influenced the direction of building strategies for this thesis. Olson Kundig's design strategies can inform how buildings meet the ground, protect themselves from the weather, and respond to their natural surroundings.



**Figure 70 - (top left) Sol Duc Cabin** (*Photo by Benjamin Benschneider*)

**Figure 71 - (bottom left) The Pierre** (*Photo by Dwight Eschliman/Olson Kundig*)

**Figure 72 - (top right) Delta Shelter** (*Photo by Tim Bies/Olson Kundig*)

**Figure 73 - (bottom right) Chicken Point Cabin** (*Photo by Benjamin Benschneider/Olson Kundig*)

## Delta Shelter

The Delta Shelter is a 1,000sqft cabin with a minimal 200sqft footprint. The house sits on 100-year flood plain in Mazama, Washington and rises off the ground in a vertical nature accordingly. The building's small footprint reduces the influence on the surrounding ecosystem and takes up no more space than is necessary. The general nature of the smaller structure helps to retain heat in the cold winters and makes it easier to protect the building when the owner isn't present. Shutters operated by a mechanical hand crank offer cover for the large windows, bringing in warm natural light when open and providing privacy, protection, and insulation when closed. The ability for the building to adapt based on occupancy and weather is an example of how structures in remote locations can increase their lifespan under seasonal transitions of climate and habitation with limited care.<sup>61</sup>

## The Pierre



**Figure 74 - Section of The Pierre residence** (*drawing by Olson Kundig*)

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<sup>61</sup> "Delta Shelter," Overview Information, accessed June 2017, <http://www.olsonkundig.com/projects/delta-shelter/>



The Pierre is an approximately 2,600sqft residence in San Juan Islands, United States on the coast of Washington State. The climate here is temperate with the potential for large amounts of precipitation year-round. Here the juxtaposition between human habitation and the natural environment is articulated through the architecture. The building is constructed within a large outcropping of rock that's located on site.<sup>62</sup>

*“Putting the house in the rock follows a tradition of building on the least productive part of a site, leaving the best parts free for cultivation.” - Tom Kundig<sup>63</sup>*

The building fills the void in the rock and contrasts the poured concrete structure against the unrefined rock present on the site. This project by Olson Kundig highlights parts of the tectonic theory outlined in the prior chapter, where the materials' level of refinement can begin to reinforce the sense place through the intentional differences or similarities in material for the building and material found on the site.

Chicken Point Cabin

*“There's a natural beauty in the way things work...it's primal. To make something that makes you stop and think, even momentarily, about how something*

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<sup>62</sup> “The Pierre/Olson Kundig,” accessed June 2017, <https://www.archdaily.com/255187/the-pierre-olson-kundig-architects-2>

<sup>63</sup> “The Pierre,” Overview Information, accessed June 2017, <http://www.olsonkundig.com/projects/the-pierre/>

*moves or changes direction connects us intimately to the natural forces in our world.” – Tom Kundig*

The Chicken Point cabin became important to this thesis for the way the building engaged the site and reacted to its surrounding through light and wind. Located in Northern Idaho, the building is 3,400sqft and sits lakeside on the edge of a wooded landscape. A large window measuring 23ft tall and 18ft wide can be opened by a mechanical hand crank, removing the barrier between the living room and the landscape.<sup>64</sup> As the user engages the hand crank, wind chimes sound, providing a warning that the window is opening while also reinforcing the sense of place through sound associated with the nautical nature of the building and site.



**Figure 75 - Mechanical hand crank that rotates the 23'x18' window. (detail by Olson Kundig)**  
**Figure 76 – Finished photo of crank and chimes. (Photo by Benjamin Benschneider/Olson Kundig)**

### Sol Duc Cabin

The Sol Duc Cabin is a private residence that is utilized as weekend home for the owners. This part of the Olympic Peninsula lies in a temperate rainforest climate,

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<sup>64</sup> “Chicken Point Cabin/Olson Kundig,” accessed June 2017,  
<https://www.archdaily.com/778809/chicken-point-cabin-olson-kundig>

on average receiving up to 140 inches of rain per year with weather that is typically wet and cold. The 350sqft cabin is lifted off the ground, protecting the structure from the often damp landscape and occasional flooding.

Made from unfinished steel and structural insulate panels (SIPS), the building can close itself off to the weather through the use of large steel shutters, similar to the ones used in the Delta Shelter, protecting the interior from harsh conditions when needed. The interior is primarily wood, glowing like a lantern in the night, reinforcing the sense of coziness and warmth that's important to comfortable conditions when building in colder climates.



**Figure 77 - Sol Duc Cabin's steel panels open and close in different states of use** (*photo by Benjamin Benschneider*)

## Chapter 7: Design

### Conceptual Design Strategies

The goals for this thesis were to reimagine a new masterplan for the Horn Point Laboratory campus that improves circulation, engages the community, and provides housing for the students, faculty, staff, researchers, and guests that visit the site, while enhancing their connection to the environment. The new master plan would not only improve the productivity of those working on campus, but reintegrate Horn Point Laboratory back into the community, increasing awareness of their research and increasing profitability.

#### Impact of Site Analysis

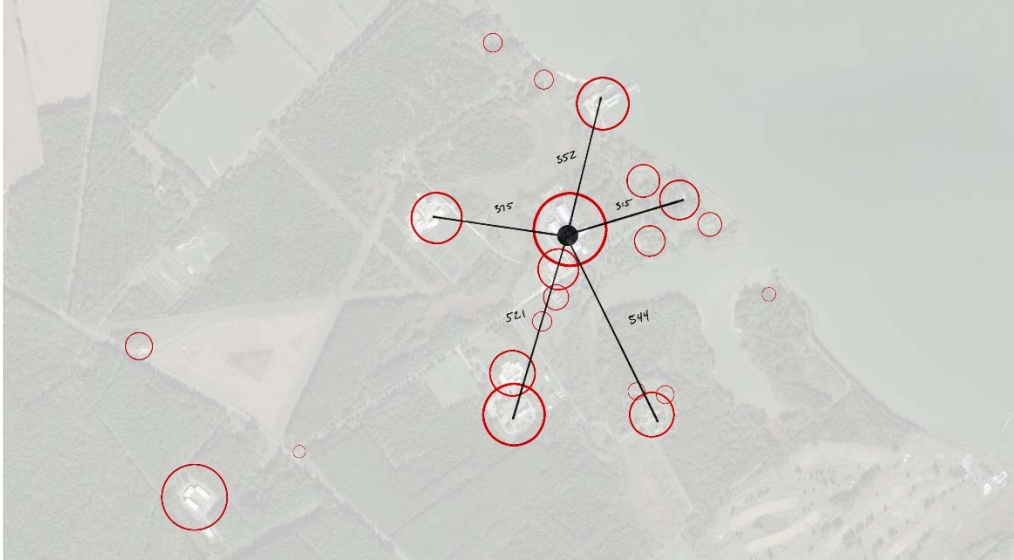
Improving circulation meant that there would be less reliance on vehicles to move people through the site, limiting the campus's impact on the environment and improving the experience on campus. Analysis showed that the current dormitory on campus housed 20-25 people and with the site handling on average up to 80 people a day during the year, and up to 100 in the summer months, the accommodations seemed insufficient. Further research showed some workers renting rooms from homeowners in Cambridge, and other workers commuting to the site from as far away as Annapolis. This highlighted an opportunity to provide more housing on site, reducing

the need for students and faculty to commute from housing offsite, while enhancing their connection to the environment in which they work.

#### Impact of Program Analysis

The need to engage the community became clear through the program analysis. There were three aspects to the site that could currently engage the community; the small museum house, the education center, and large swaths of parkland that could be used for hiking, birding, camping, and other outdoor activities. The small museum that was located on the fringes of the campus boundary was ridden with asbestos and no longer operational. This building, along with the education center, were the only two structures that might bring the community onto campus and both needed rejuvenation.

In addition to the possibilities for community engagement, a new Coastal Sciences laboratory was being discussed, with the possibility of adding an additional 30,000sqft building to the site. Given the great distances between each set of buildings, the addition of a new laboratory meant these distances could be reduced and circulation could be improved.



**Figure 78 - Distances between buildings measured in yards** (*drawing by Author*)

### Site Strategies

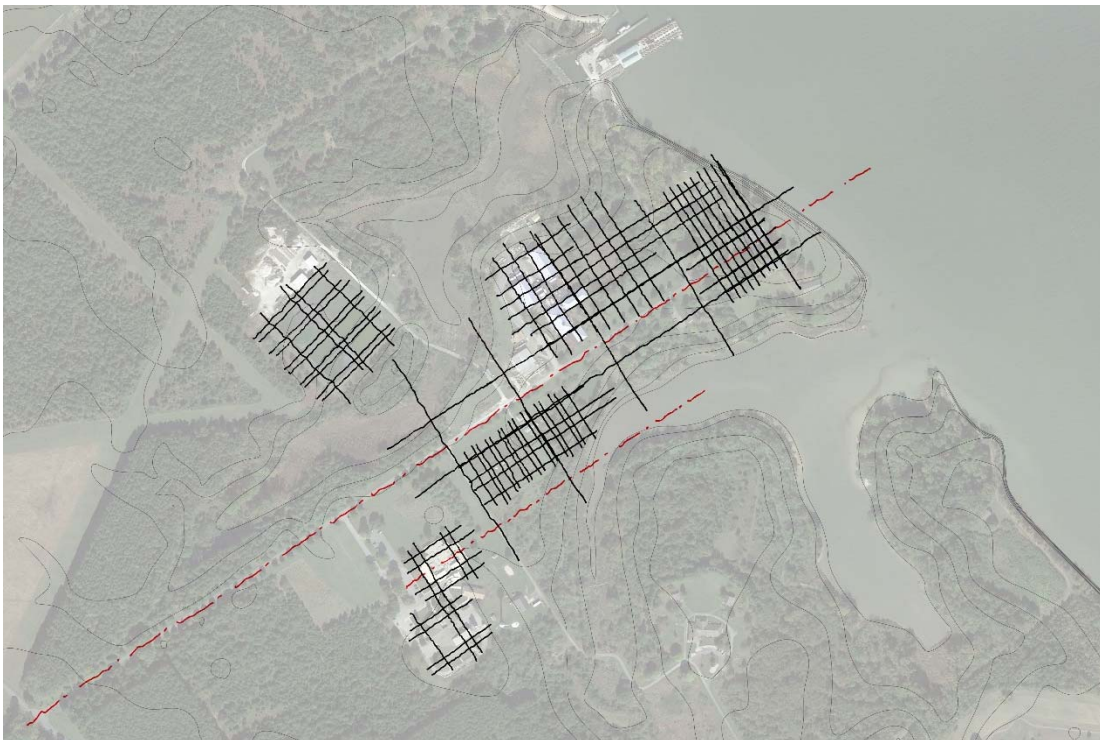
The design for the master plan was approached from the framework of an organizational grid that tied together each of the buildings on site. Not a grid of roads, and pavement, but site lines, axis, and edge conditions. This framework would create a subconscious connection between each of the elements on site without dominating the environment in the process. The master plan was divided into two primary areas of focus, the built environment where people would work and operate most of the day, and the natural environment, where they would retreat to in the evening.

#### The Built Environment

Analysis of the current buildings and human characteristics already on site showed a pattern of development that could be extrapolated into a larger framework for the proposed buildings in the built environment portion of the site.

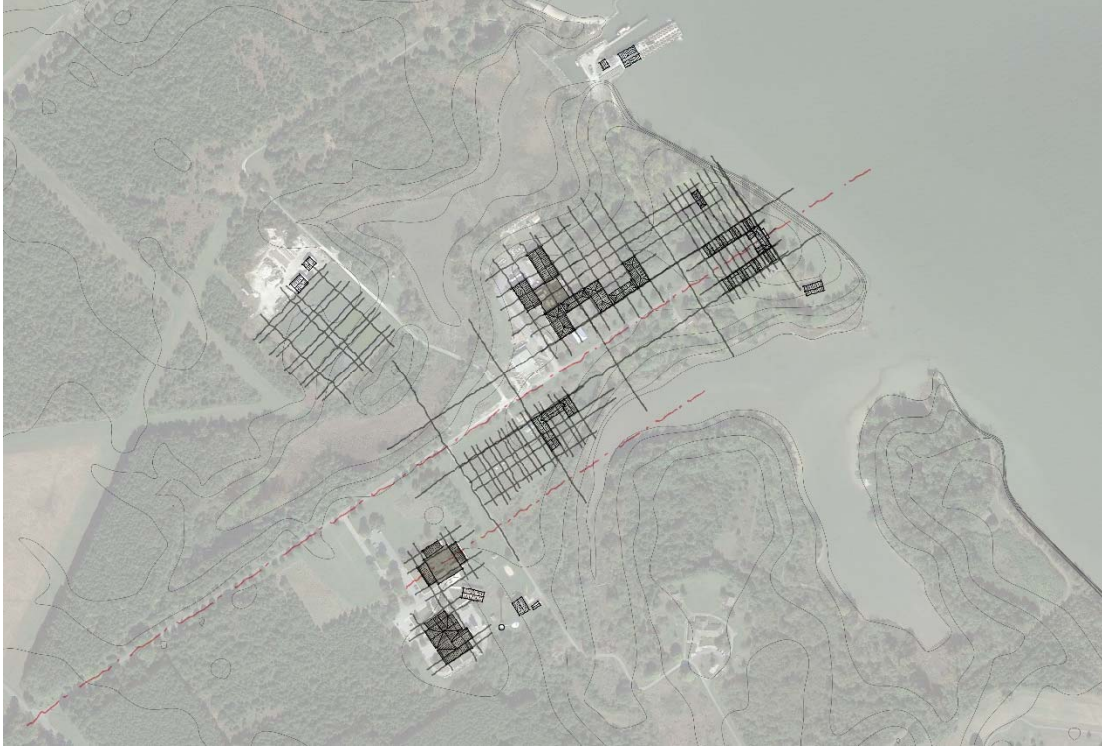


**Figure 79 - Existing patterns, extracted from the human impressions on site** *(drawing by Author)*



**Figure 80 - Existing patterns expanded into a larger framework for the proposed masterplan** *(drawing by Author)*





**Figure 81 - Site framework from proposed masterplan** *(drawing by Author)*

#### The Natural Environment

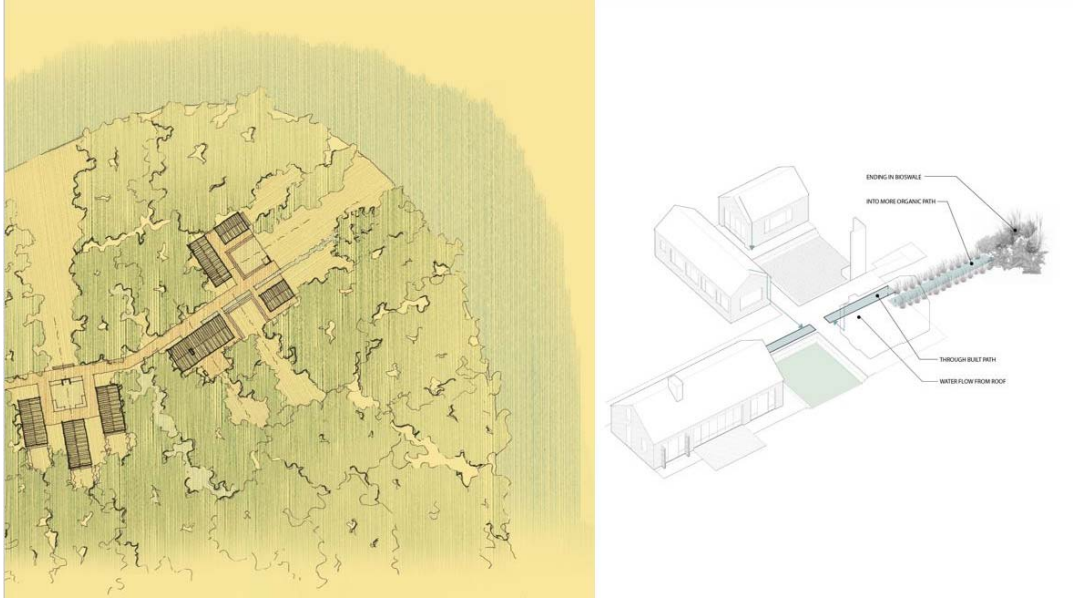
One of the main design strategies for the natural environment portion of the site was to look back at the historical impressions that were visible from time past. The historic site plan created to analyze the site when it was owned by the Dupont family highlighted irrigation canals that were formed on the peninsulas as part of the agricultural system that was used at the time. The remnants of these irrigation canals provided a framework to place the string of cabins that would be used as housing for students, faculty, staff, and researchers visiting the site throughout the year.





**Figure 82 - Historic irrigation canals used as framework for cabin strings** *(drawing by Author)*

The strings are headed by a professor's cabin and study house which form two communal areas with views out to the water. It is this head to the cabin string that is positioned along the same irrigation lines that were present on the historic site. This moment is celebrated by the way the buildings collect and channel rainwater away from the cabins and into a bioswale, before the water reaches the bay. The tails of the string, composed of smaller studio cabins, is then free to be positioned and orientated based on the topography, solar conditions, wind, and views out into the landscape.



**Figure 83 - Professor's cabin and study house forming head of cabin string and positioned according to historic irrigation canals** (*drawing by Author*)



**Figure 84 - Approach to the head of the string and water collection** (*drawing by Author*)

### *Building Strategies*

The cabins were designed to not only foster a stronger connection with the environment, but encourage a stronger connection with the various types of people working and living on site. The way the cabins form exterior spaces was just as important to the design as the way they form interior spaces. Both the professor's cabin and studio cabins are designed to form communal spaces that encourage engagement and interaction between students, faculty, and researchers.

#### *Access*

Circulation on site is facilitated by existing roads for vehicular traffic, as well as new pedestrian paths that improve movement between the buildings on site. In order to encourage people to leave their cars and move through the site in a sustainable way, the design seeks to improve the pedestrian experience. The path system is designed to facilitate more direct movement between buildings as well as a more experiential movement that is highlighted by connections with the natural environment and views across the bay. Both path systems are lined with deciduous tree cover that provides shade in the summer and protects path users from the rain. Sustainable parking areas, with permeable pavers and vegetation strategically placed to deal with rainwater, are introduced in the natural environment portion of the site for easier access to the cabins.

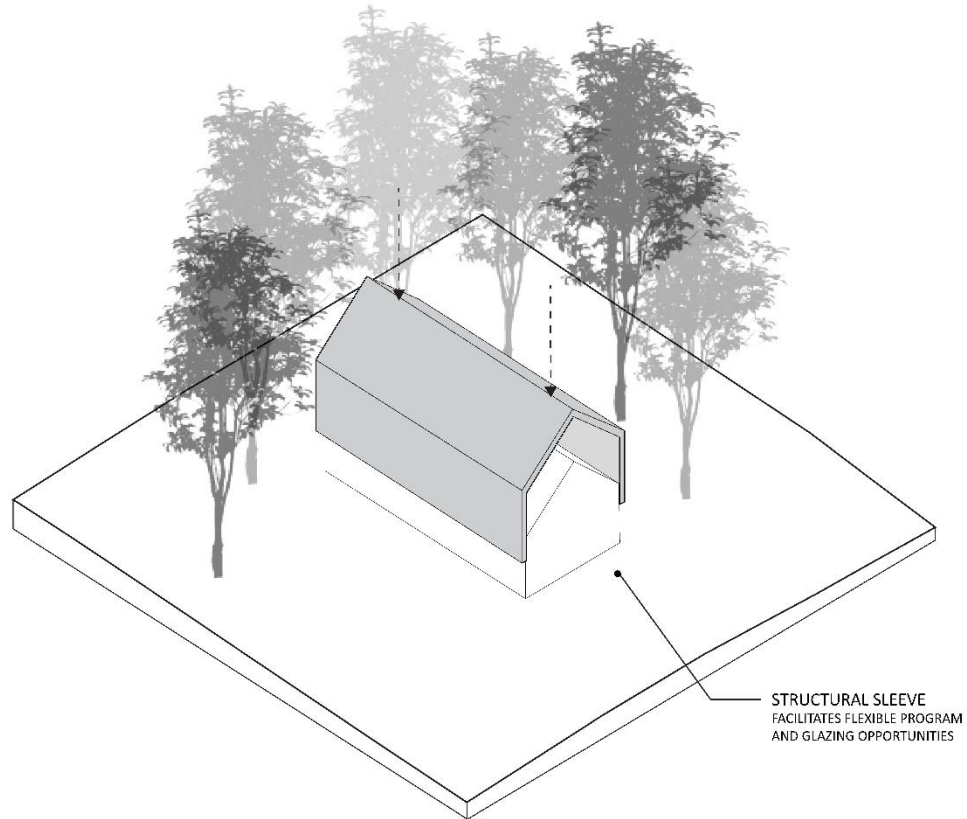


**Figure 85 - Circulation through the site, vehicular paths in black and pedestrian paths in red**  
*(drawing by Author)*

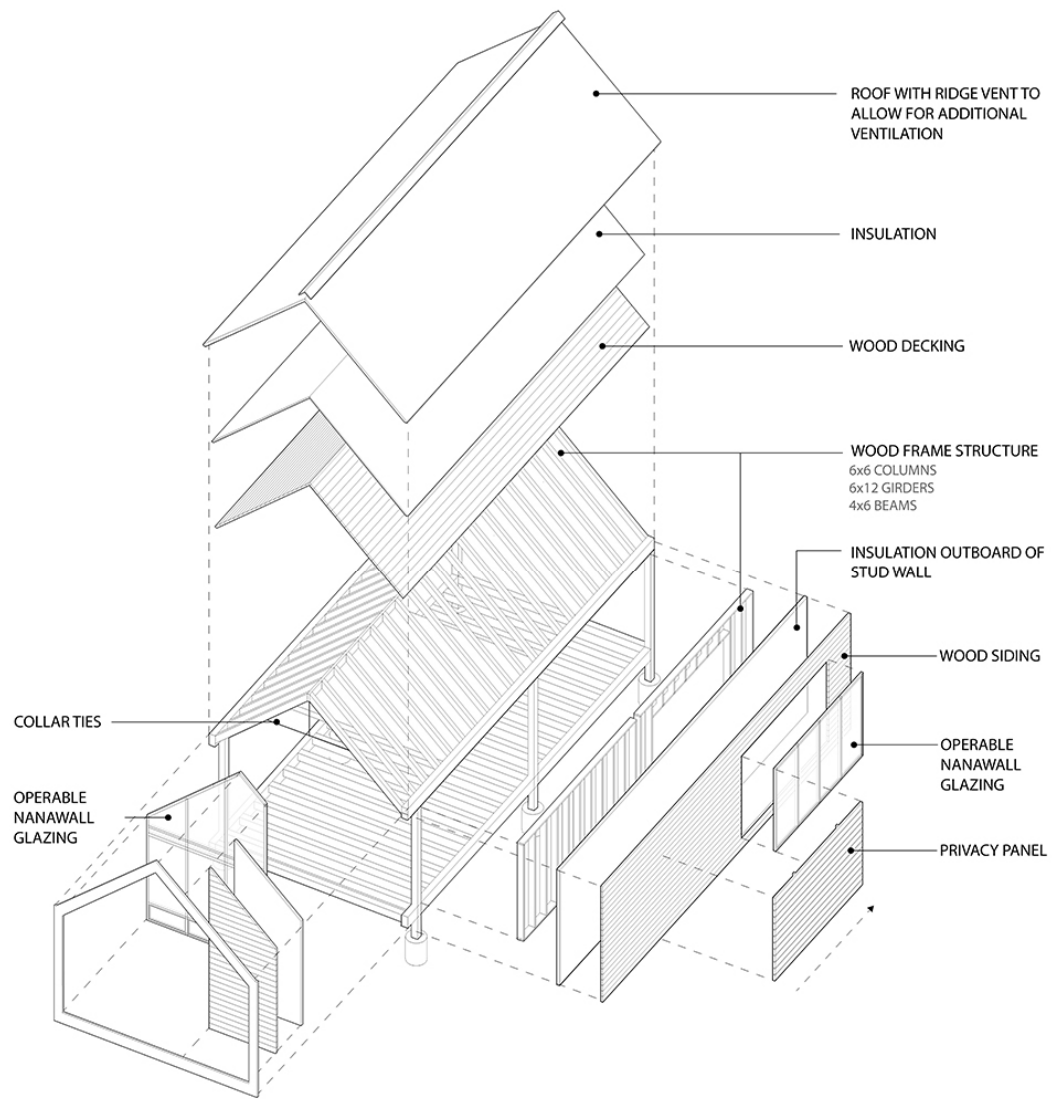


## Studio Cabin

The parti of the studio cabin was based around the idea of a structural sleeve. The structural sleeve would house all the necessary structural elements to make the interior as flexible as possible. This also allowed pushing and pulling of façade elements to create various ways of blurring the boundary between the interior and exterior. The flexibility provided to the interior spaces removes the need for unique designs that might be desired for individual program requirements, facilitating easier construction and reducing cost.

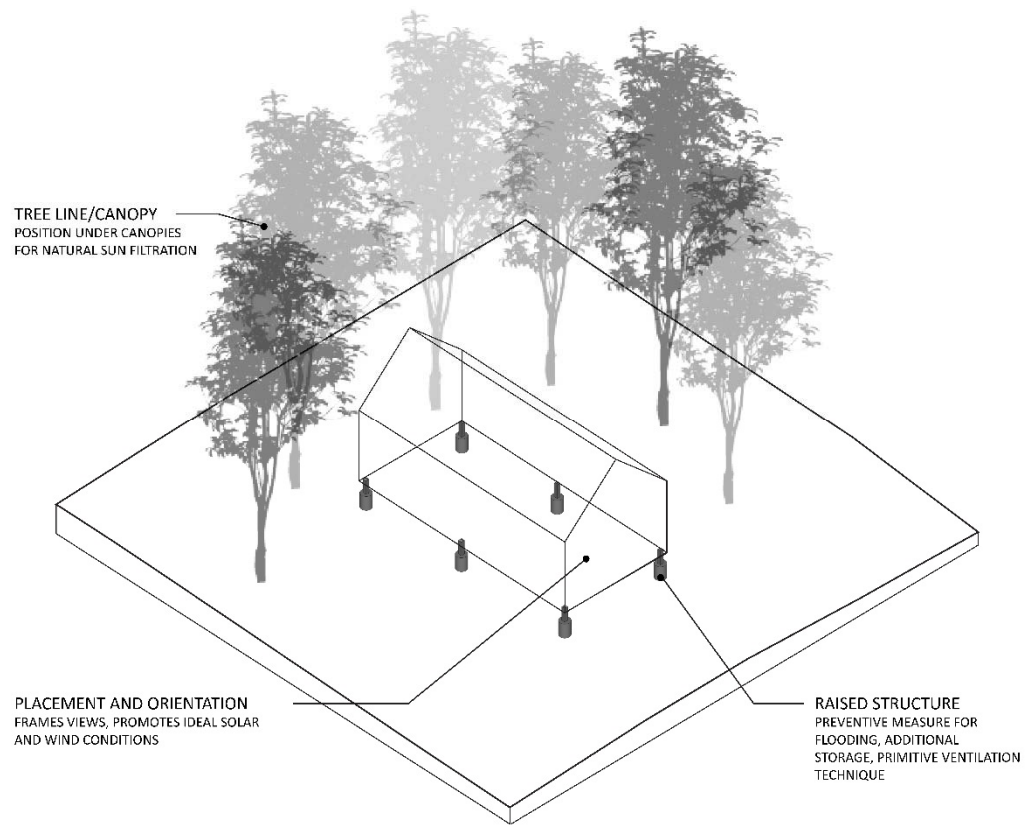


**Figure 86 - Parti of studio cabin** (*drawing by Author*)



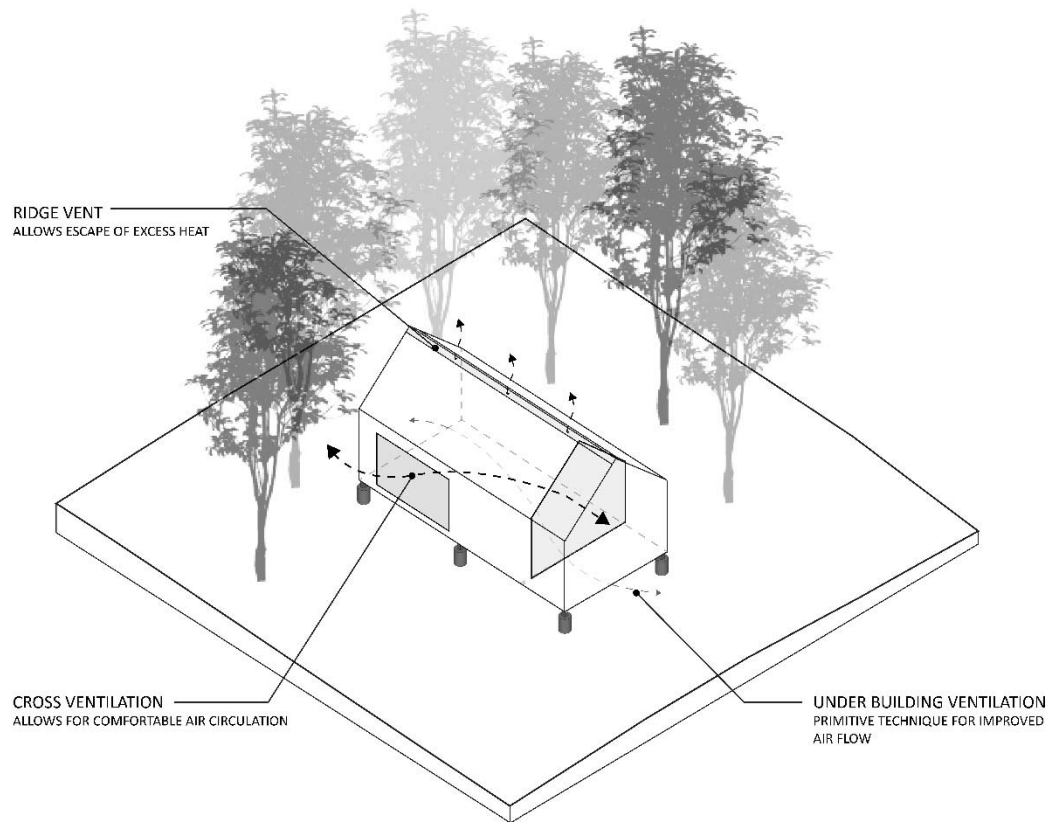
**Figure 87 - Exploded axon showing components of structural sleeve** *(drawing by Author)*

The design of the cabins is such that it makes the best use of the surrounding site conditions. The structure is raised off the ground on footings as a preventive measure for flooding, to provide additional storage for larger items, and to facilitate better ventilation in and around the building. The placement of each cabins was decided based on the ideal local solar and wind conditions, while framing views into the landscape. Careful consideration of the cabins relationship to the surrounding trees provides opportunities for natural sun filtration in the summer, reducing the need for large overhangs and window covers.



**Figure 88 - Site conditions diagram** (*drawing by Author*)

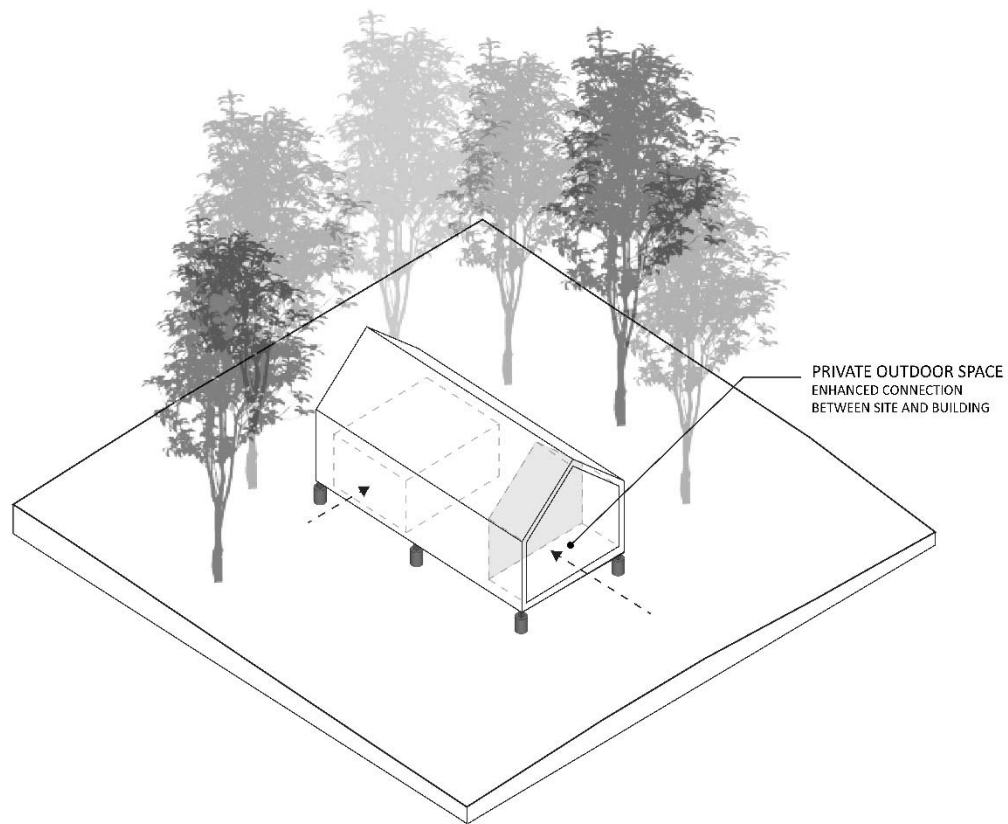
The studio cabins were designed to make the best use of natural ventilation techniques to reduce the reliance on mechanical systems. The large openings on two sides of each cabin provide ideal circumstance for cross ventilation and increased air flow. Ridge vents positioned at the peak of the gable roof help release excess heat in the summer.



**Figure 89 - Ventilation techniques** (*drawing by Author*)

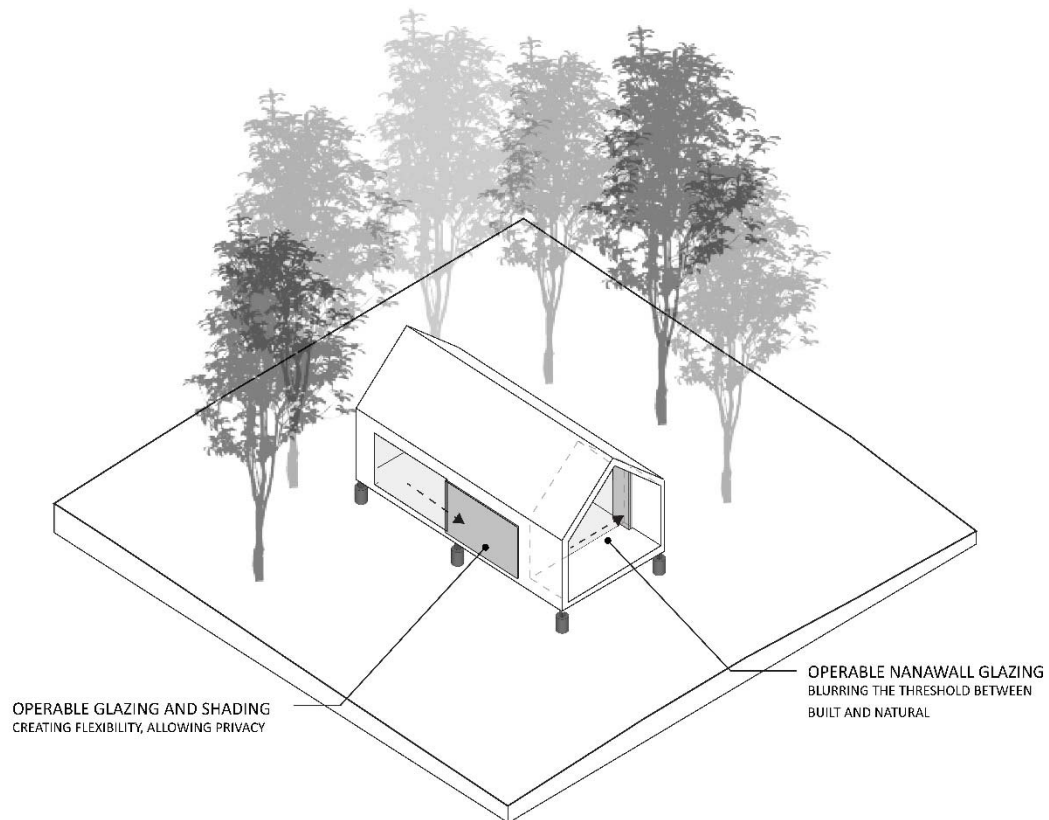


The importance of connecting each resident to the environment around them cannot be understated. The design of each cabin was based around facilitating this connection and creating opportunities to interact with and view nature. The structural sleeve of the studio cabin provided the opportunity to push and pull façade elements, allowing for the southern façade to be pushed back into the sleeve by 6ft. This creates a private porch area for each studio cabin, giving the resident multiple ways in which they can sit outside and enjoy the environment around them.



**Figure 90 - Indoor/Outdoor connection** *(drawing by Author)*

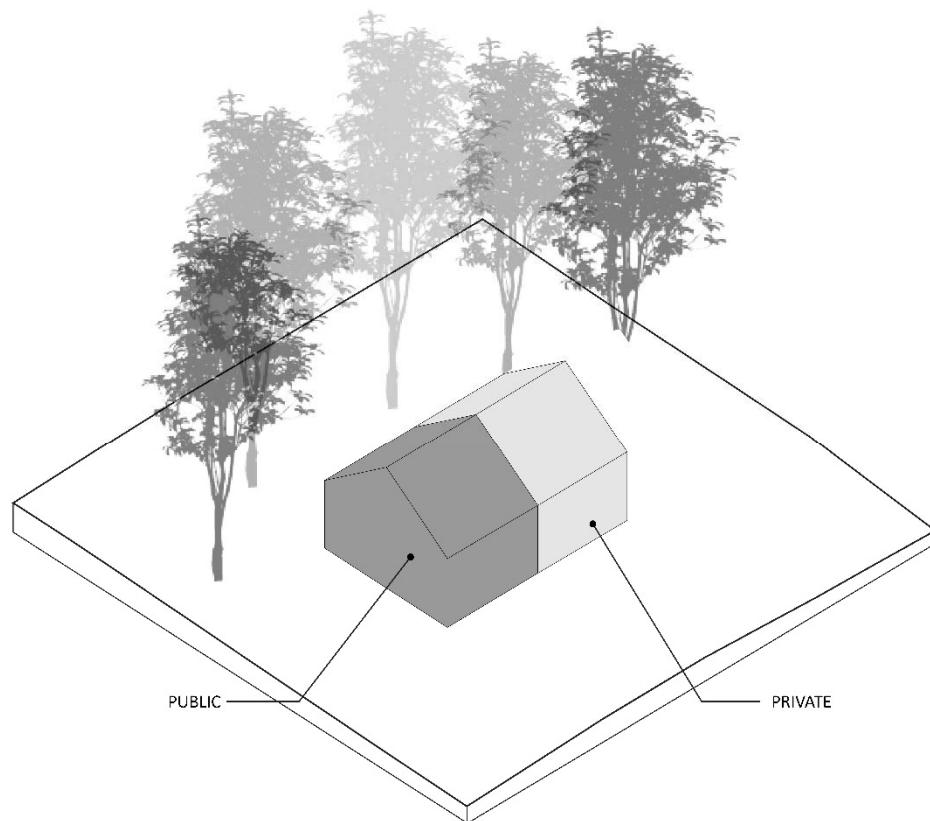
Helping to blur the line between the interior and exterior, the primary facades are built with Nanawall glazing, allowing the barrier to the outdoors to be completely removed. Privacy panels can be moved to cover the large openings when needed, and also provide protection for the glazing when the cabins are unoccupied or during severe weather events.



**Figure 91 - Nanawall glazing and privacy panels animate the facade to enhance the connection to the surrounding environment** *(drawing by Author)*

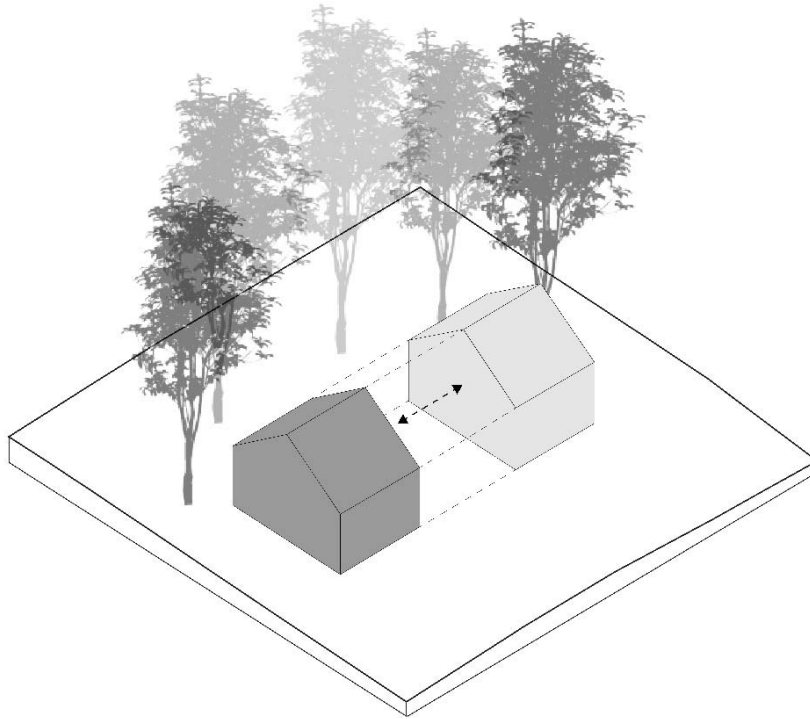
## Professor's Cabin

The professor's cabin and study house was designed to encourage community and interaction with other students and researchers living on site. As such, the ideal program for the cabin would need to manage the public and private areas in a way that provided adequate privacy for the resident while creating communal spaces that felt open to visitors. This idea sparked the design for the form of the building by separating the more private programs to one end of the cabin and the more public program to the other – creating a space between the two that acts as the threshold between public and private activities.



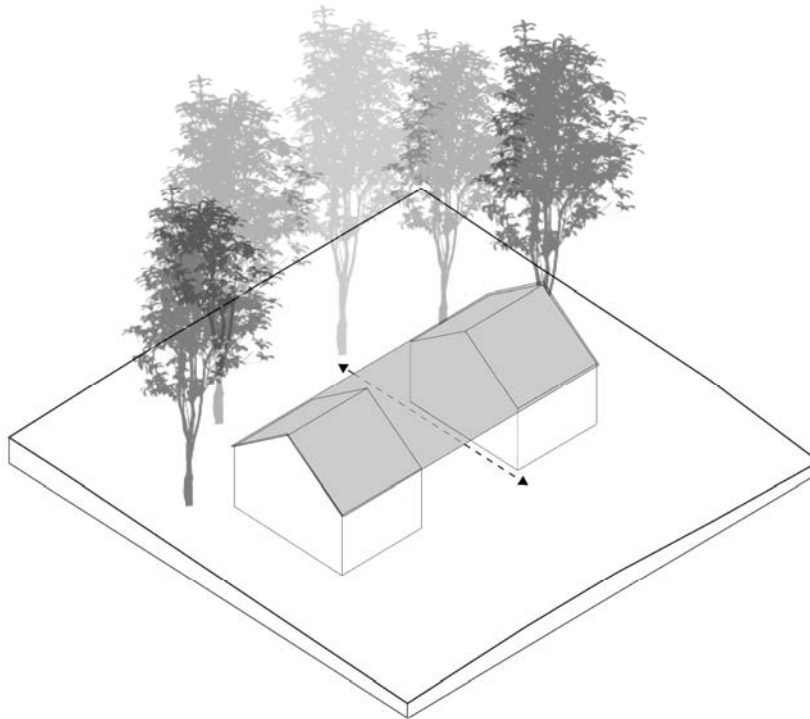
PART I: designating program

**Figure 92 - Designating public and private sides of the cabin** *(drawing by Author)*



PART1: creating separation

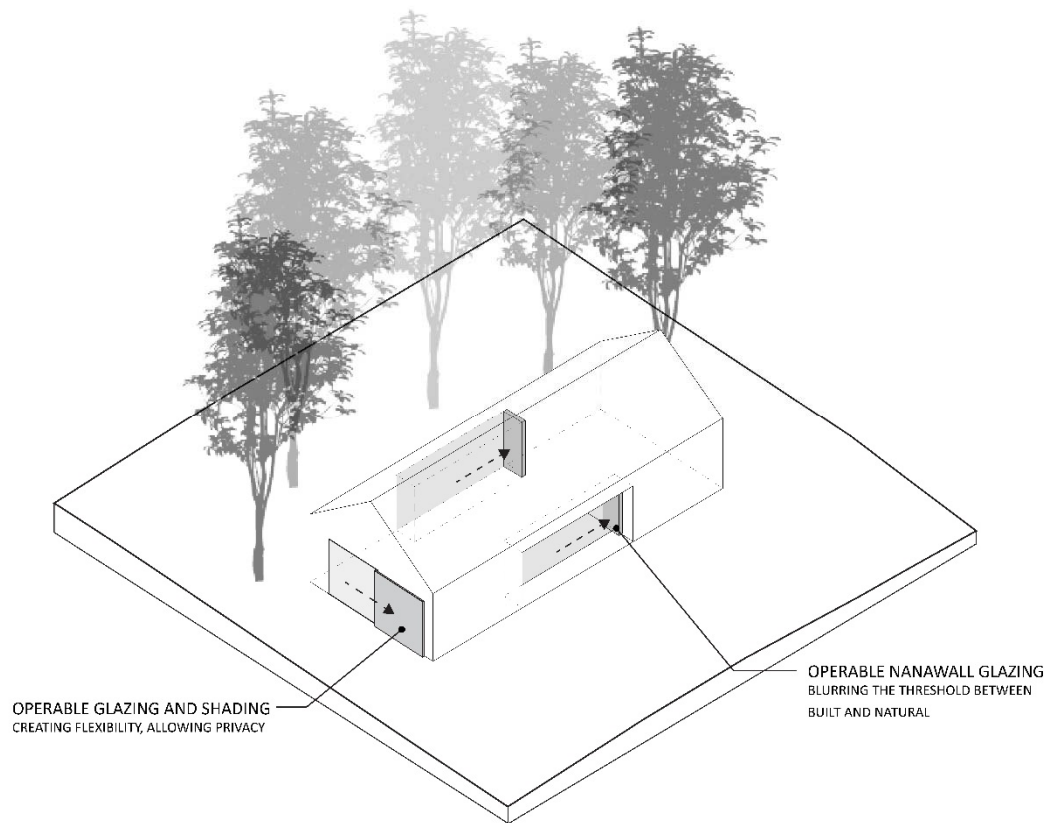
**Figure 93 - Separating the public and private zones for communal area between the two** *(drawing by Author)*



PART1: creating indoor/outdoor connection

**Figure 94 - Threshold space ideal location for indoor/outdoor connection** *(drawing by Author)*

Like the studio cabins, the professor's cabin is designed to enhance the connection of the resident to the environment around them. To do this, the glazing in the primary gathering spaces can be opened to remove the barrier between the interior and exterior.



**Figure 95 - Glazing on three of the four facades can be opened to remove barrier to the to the surrounding environment** (*drawing by Author*)

## Final Design



**Figure 96 - Proposed masterplan for Horn Point Laboratory campus** (*drawing by Author*)

The final design for this thesis proposes a new master plan for the Horn Point Laboratory campus that improves circulation, introduces new program, engages the community, and provides housing to the students, faculty, and staff that work on site. The primary components introduced in the masterplan include the new Coastal Sciences laboratory, administration offices adjacent to the historic Dupont residence, a new education center, and the housing cabins located on the southeastern portion of the site. In addition to these new structural components, the masterplan also introduces a new path system, agricultural area, and outdoor gathering spaces.



The new Coastal Sciences laboratory is built as an addition to the AREL laboratory along the primary road through the site. The introduction of the new laboratory not only provides additional facilities for research on the environment, but creates a new entrance along the main road and a communal space for researchers to gather and share ideas.

Administration offices are built adjacent to the Dupont residence to provide more space for faculty and staff working on site. Their location helps to group the administrative program in one central location, increasing efficiency and improving productivity. The positioning of the new offices forms the primary lawn at the end of the main axis, helping to distinguish the location as a notable area on site and providing a gathering space for staff to engage the environment.

The new education center is moved from the southern end of the campus to a more centralized location along the main drive. This location helps to identify the building as the primary destination for visitors of the campus. In addition to the existing program of classrooms, kitchen, and dining areas, the new education center includes a larger event space, linear gallery, and exhibition space. The introduction of this new program can help generate additional revenue for the site, hosting weddings and other larger scale gatherings. The form of the building helps shape a courtyard on the southern side of the building, with views out over the Chesapeake Bay. These features help make the education center a primary location and hub of activity on site.



**Figure 97 - Housing cabins introduced on the southeastern portion of the site** (*drawing by Author*)

The most significant addition to the Horn Point Laboratory campus is the housing cabins introduced on the southeastern portion of the site. Ten strings of cabins placed strategically through the natural environment provide housing for students, faculty, and researchers in a way that creates a stronger connection with their field of study, the environment. Each string of housing includes clusters of studio cabins, a professor's cabin, and study house, while also providing communal spaces to encourage community and group activities.

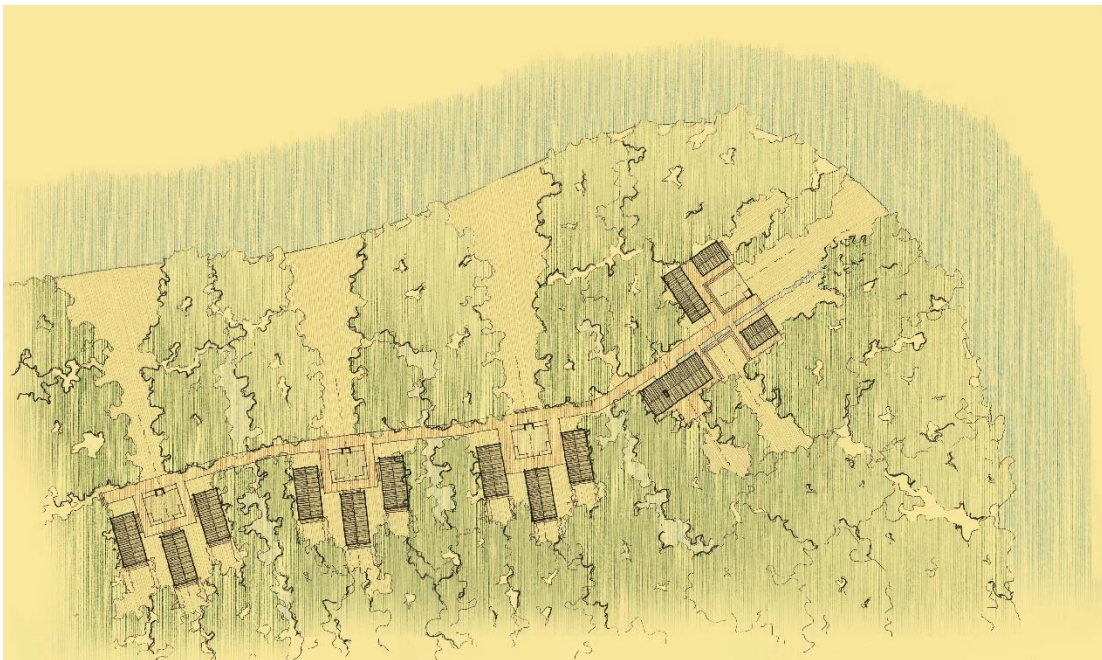
By dividing the campus into two distinct sections, the built environment and the natural environment, the housing acts as a retreat from civilization – a place for the people working on campus to retreat, without removing them from their work environment. The procession of this commute into and out of the natural environment



enhances their connection to place and reinvigorates their passion for nature after a long day. This procession is accentuated by views into the landscape and site lines that enhance the pedestrian experience.



**Figure 98 - Procession into the natural environment** (*images and drawings by Author*)



**Figure 99 - String of cabins in the natural environment on site** (*drawing by Author*)

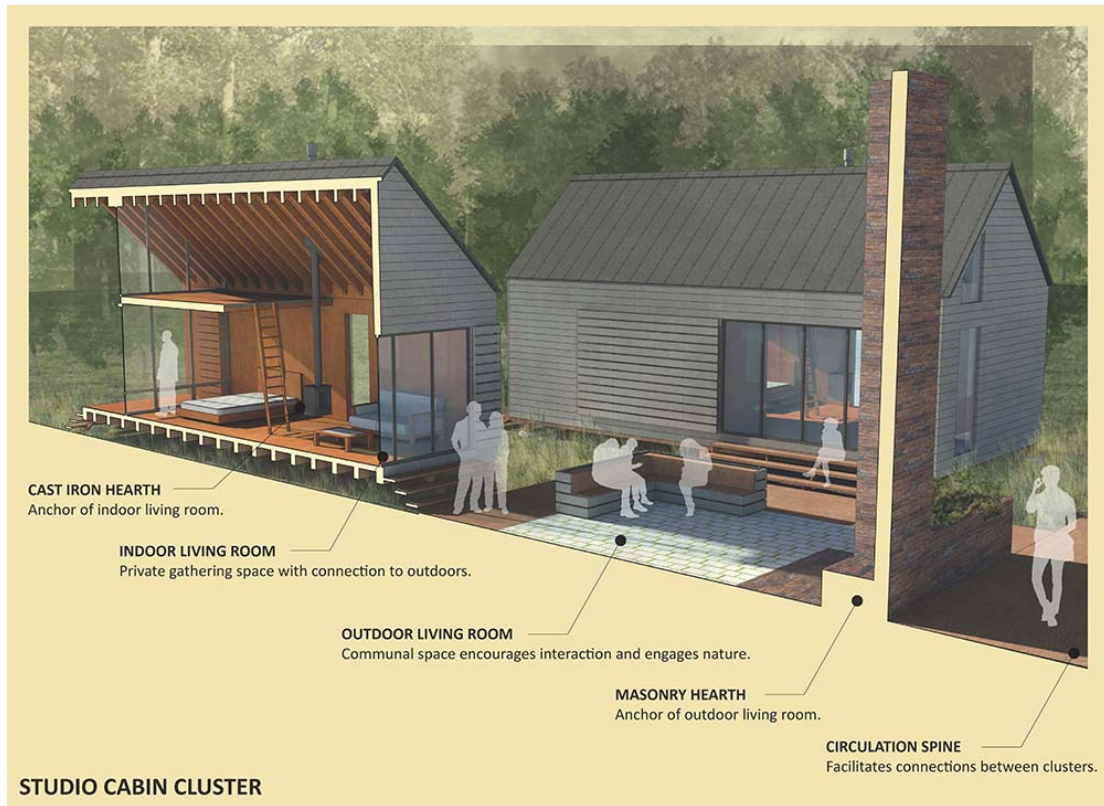
## Studio Cabins

The primary resident of the studio cabins are students, graduate assistants, and people staying on campus for shorter periods of time. The 560sqft cabins have standard amenities, including a kitchen with refrigerator, stovetop, and sink, as well as a full bathroom that includes a shower. The studio cabins are clustered in groups of three and create an outdoor living room that is anchored by a masonry hearth. These outdoor living rooms provide spaces for the residents to gather outside of their individual residences. The hearths act as markers in the landscape, helping to identify each cluster and connecting the resident to their individual sense of place.



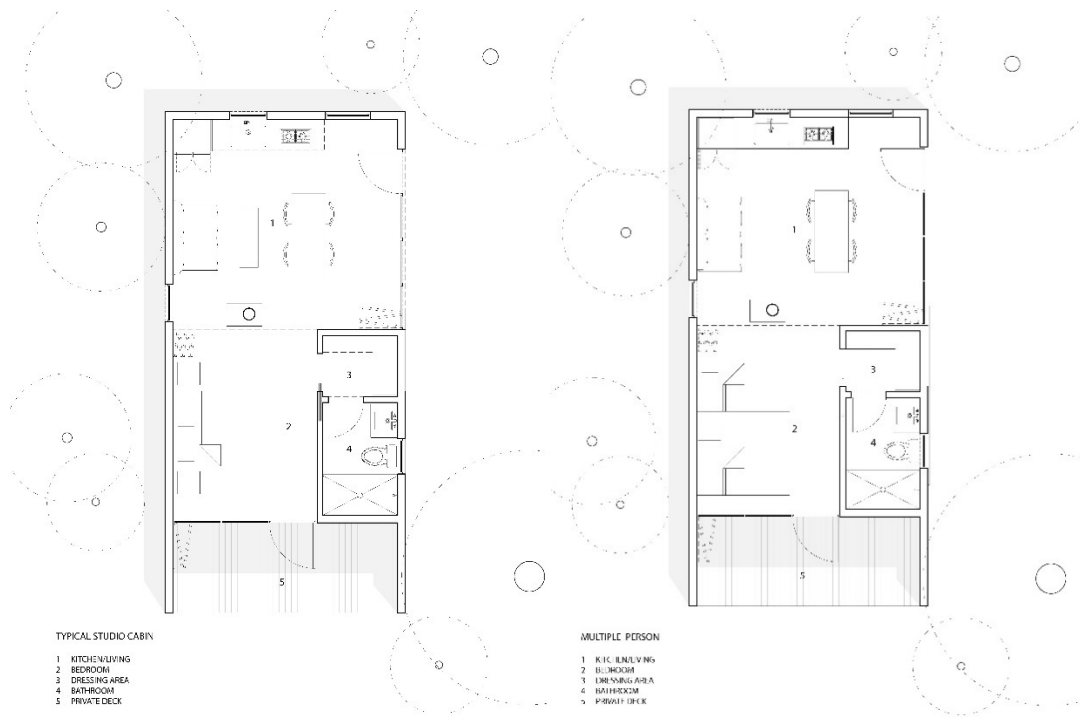
**Figure 100 - Communal space formed by cluster of studio cabins** *(drawing by Author)*





**Figure 101 - Section perspective showing relationship of hearth to living spaces** (*drawing by Author*)

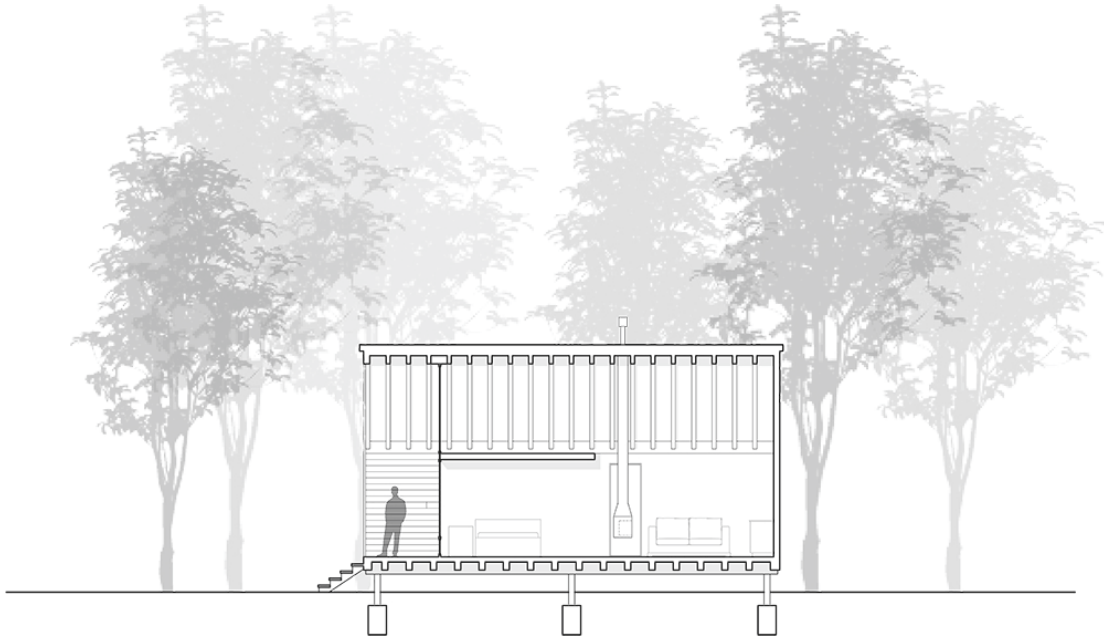
The studio cabins are designed to be able to facilitate a variety of different types of users. The typical cabin layout includes a kitchen and living space, bedroom, dressing area with storage, bathroom, and private deck. The design of this layout is such that it keeps the more public spaces located to the northern end of the cabin, adjacent to the outdoor communal space. Both primary spaces, the living area and the bedroom, are provided with grand views into the landscape. The glazing along the southern and eastern walls can be completely opened to the environment, removing the boundary to the outdoors and creating an almost camping-like experience for the resident.



**Figure 102 - (left) Typical studio cabin layout** *(drawing by Author)*

**Figure 103 - (right) Studio cabin layout with multiple residents** *(drawing by Author)*

A loft above the bedroom provides a flexible space that can be used for storage, an additional bed, or office space. Between the bedroom and living space is a cast iron hearth which provides heat in the winter and helps anchor the living room around a communal design element.



**Figure 104 - Section taken through the center of the studio cabin** *(drawing by Author)*

The large openings on the southern and eastern facades can be covered by large wooden panels if required. These panels slide into place depending on the needs of the resident, such as privacy or a vacant cabin. These panels give the cabins a unique look depending on when they're open or closed. In the fall and winter months when there may be fewer residents, the panels can be closed to help protect the glazing from the weather.



**Figure 105 - Studio cabins in the summer and fall** *(drawing by Author)*



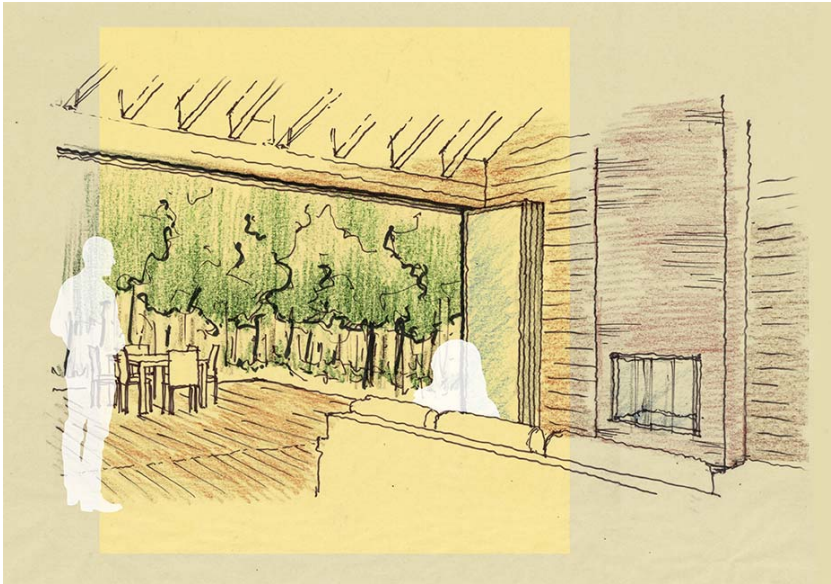
**Figure 106 - Southern facades highlighting private porch areas of studio cabins** (*drawing by Author*)

#### Professor's Cabin

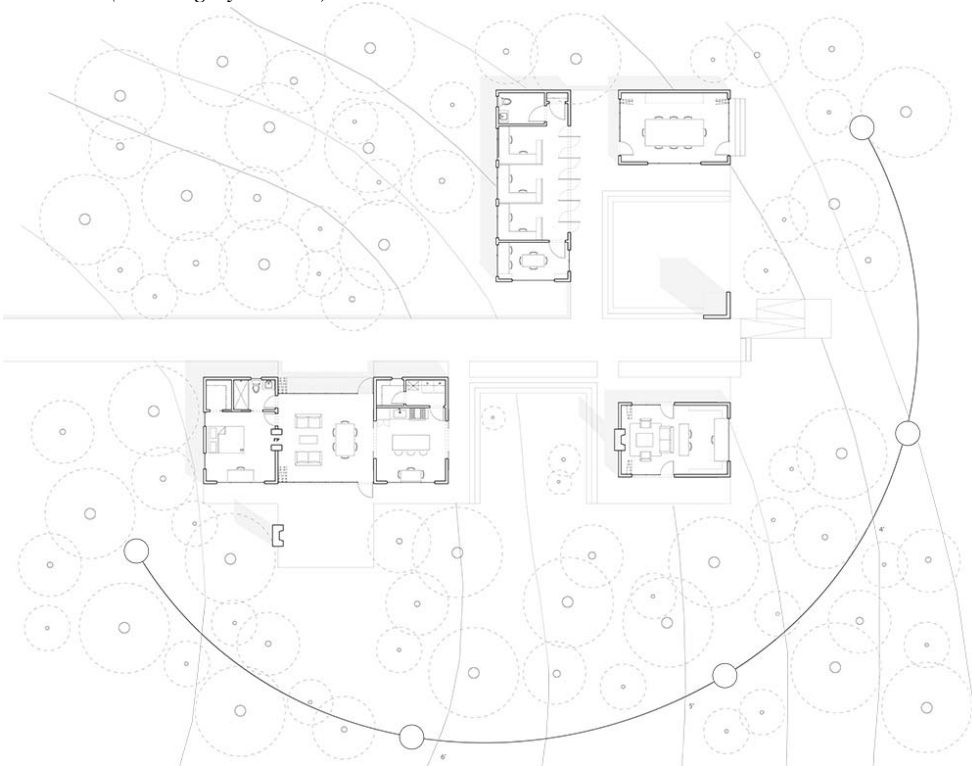
With its position at the head of the cabin string, the professor's cabin is designed to engage the residents staying in the studio cabin while maintaining privacy of the inhabitant. The 920sqft cabin divides the program into private and public sectors, with the space between them acting as a threshold used as living space that can adapt to be either private or public. The private portion of the cabin includes the bedroom, full bathroom, and walk-in closet. The public side includes a large kitchen space with countertop island, breakfast area, pantry, and utility room with washer and dryer. The threshold space then becomes the living room, anchored by the hearth that is flanked by a seating area and dining table that is big enough to host residents of the



other cabins. Sliding doors in the kitchen open onto a communal green space that captures a portion of the natural environment.



**Figure 107 - Living room of professor's cabin with Nanawall glazing removing the barrier to the outdoors** (drawing by Author)



**Figure 108 - Layout of professor's cabin, private study, study house, and conference cabin** (drawing by Author)

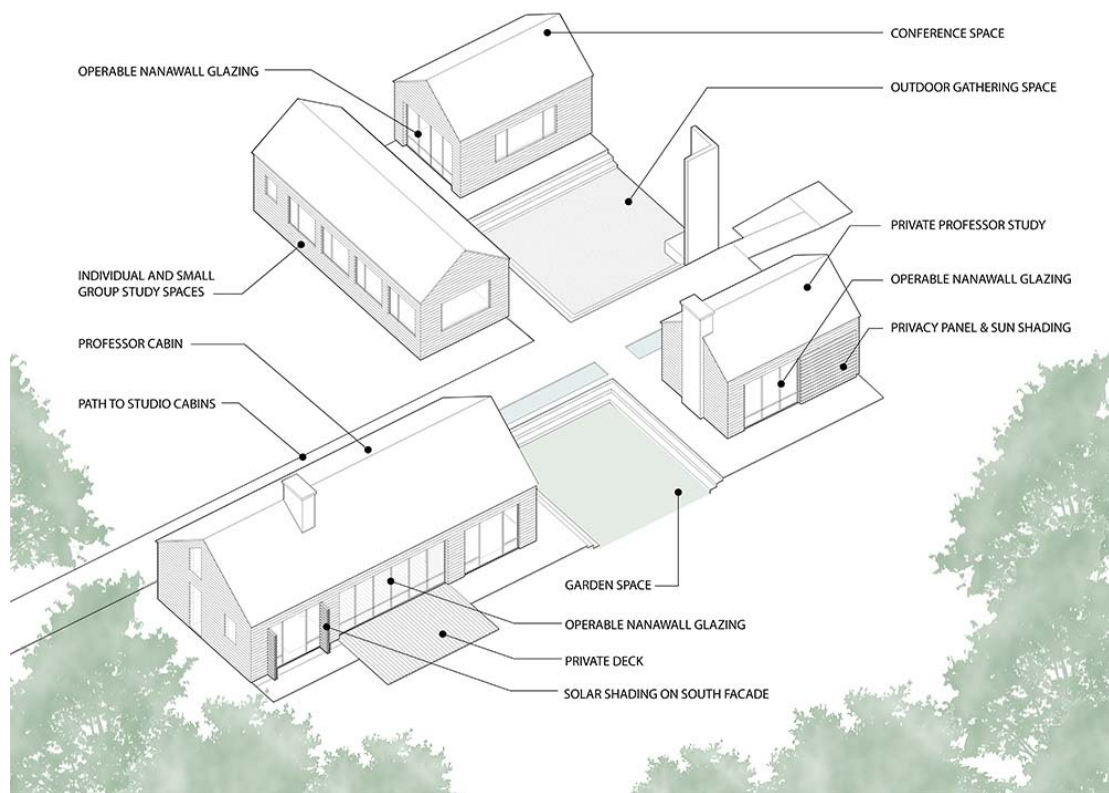
In addition to the main cabin, a private studio, study house, and conference cabin, make up the adjacent structures at the head of the string. The private studio is a quiet reflection space for the resident of the professor's cabin, with a large seating area, shelf space, and desk. The desk sits below a large window that frames views into the landscape and over Chesapeake Bay.



**Figure 109 - Private study framing views into the landscape** (*drawing by Author*)

The study house is made up of individual and small group study spaces, storage, and a bathroom. Across from the study house is a small conference cabin for larger gatherings or researchers who need a larger workspace. These study spaces provide a place for residents of the cabins to study or perform research that is away from the built environment of the campus and surrounded by nature. These spaces implement design strategies that blur the line between interior and exterior spaces, bringing the residents closer to their surroundings and enhancing their connection to the natural environment.





**Figure 110 - Head of cabin string with the professor's cabin, private study, study house, and conference cabin** *(drawing by Author)*

## Chapter 8: Conclusion

### Thesis Aggregation

This thesis explores the opposition between wilderness and civilization and analyzes how architecture can facilitate the relationship between the built environment and the natural environment. By taking cues from the natural conditions on site and creating a framework that brings order and meaning to the way buildings relate to one another through non-destructive means, we can feel deserving of that environment without dominating it. The Horn Point site represents a microcosm of the opposition between humans and the environment and facilitates the opportunity for an academic life that moves between the natural and built environment on a daily basis. This design allows for the people who work on the Horn Point campus to retreat into the wilderness in the evening and commute to civilization in the morning – the procession of which enhances their connection to place, invigorates the mind, and facilitates a stronger connection to their field of study, the environment.

The ideas implemented in this thesis can be extrapolated to different climates, countries, and circumstances. Architecture is the physical merger between humans and the landscape. It is an architect's duty to ensure that their designs not destroy the landscape, but enhance it. Analysis and abstraction of these landscapes can facilitate buildings that are not only more aesthetically pleasing and functional, but sustainable

and energy efficient. These features benefit not only the environment, but the inhabitants of these environments.

### *Moving Forward*

Moving forward this thesis will explore how these design principles can be adapted to various climates and topographical conditions. The threshold between the interior and exterior of the building can be further developed to engage the user in a way that activates a stronger sensory connection, further enhancing their experience with the building and the environment.

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